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SURFACE TO 90 km WINDS FOR KENNEDY SPACE CENTER, FLORIDA, AND VANDENBERG AFB, CALIFORNIA

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TECHNICAL MEMORANDUM*

SURFACE TO 90 km WINDS FOR KENNEDY SPACE CENTER, FLORIDA, AND VANDENBERG AFB, CALIFORNIA

INTRODUCTION

This document updates two previously published documents [1,2] and presents empirical, bivariate normal (Gaussian) wind component statistics for Kennedy Space Center (KSC), Florida, and Vandenberg AFB (VAFB), California, for altitudes 0 through 90 km. The bivariate normal statistics for all months, January through December, for the 90 degree flight azimuth are given in tabular form as well as presented in figures. The normal distribution was not applied to the annual reference period since this is a heterogeneous sample and should not be represented by a univariate statistical model.

The standard meteorological notation for this 90 degree flight azimuth defines u as the zonal wind component (+ from west) and v as the meridional wind component (+ from south). The sample estimates of the theoretical mean μ are $\bar{u}$ and $\bar{v}$. The sample estimates of the theoretical standard deviation σ of the zonal and meridional wind components are S(u) and S(v), respectively. R(uv) is the sample estimate of the theoretical correlation coefficient between u and v, while N is the sample size. The five statistics $\bar{u}$, $\bar{v}$, S(u), S(v), and R(uv) completely define a bivariate normal elliptical distribution. From these five parameters the probability distributions described by Smith [3] and the statistics for any rotation of the orthogonal axes through any arbitrary angle α, presented by Falls and Crutcher [4], can be computed. This interest is motivated from an application of wind component statistics with respect to any flight azimuth of an aerospace vehicle. Because of this important application, the necessary expressions for this operation, given in Reference 4, are repeated here. Presented are the final rotational equations for the means, variances, and correlation coefficients:

1) Rotation of the means through α degrees:

$$\bar{u}_{\alpha} = \bar{u} \cos (90 - \alpha) + \bar{v} \sin (90 - \alpha)$$

$$\bar{v}_{\alpha} = \bar{v} \cos (90 - \alpha) - \bar{u} \sin (90 - \alpha)$$

* This document supersedes TMX-64771 [1] and TMX-64897 [2] and should be used in place of them.

2) Rotation of the variances through α degrees:

$$S(u)^2_\alpha = S(u)^2 \cos^2 (90 - \alpha) + S(v)^2 \sin^2 (90 - \alpha) + 2R(uv)S(u)S(v) \cos (90 - \alpha) \sin (90 - \alpha)$$

$$S(v)^2_\alpha = S(v)^2 \cos^2 (90 - \alpha) + S(u)^2 \sin^2 (90 - \alpha) - 2R(uv)S(u)S(v) \cos (90 - \alpha) \sin (90 - \alpha) .$$

3) Rotation of the linear correlation coefficient $R(uv)$ through α degrees:

$$R(uv)_\alpha = \frac{S(uv)_\alpha}{S(u)_\alpha \, S(v)_\alpha}$$

where $S(uv)_\alpha$ is the rotated covariance expressed as:

$$S(uv)_\alpha = S(uv) \left[\cos^2 (90 - \alpha) - \sin^2 (90 - \alpha) + \cos (90 - \alpha) \sin (90 - \alpha) \left(S(v)^2 - S(u)^2\right)\right]$$

and

$$S(uv) = R(uv)S(u)S(v) .$$

By using these rotational equations, the bivariate normal distribution with respect to any desired rotated coordinates can be obtained from sample estimates that have been computed with respect to a specific axis. The marginal distributions after rotation are also normally (univariate) distributed. By using the rotational equations, computational efforts are greatly reduced for applications requiring statistics with respect to several coordinate axes.

DATA USED

This report updates the empirical wind data samples previously used from 0-27 and 28-70 km altitude regions for KSC and VAFB, with the data presented being extended to 90 km altitude. Both 0-27 km data samples used serially complete data with 13 880 observations (N) extending over a 19-year

period (January 1956 through December 1974) available at all 28 altitude levels for KSC, and N = 7 304 observations from January 1965 through December 1974 for VAFB. The serially complete data are obtained from twice daily radiosonde balloon releases at each site, with the exception of KSC releases between January 1962 and December 1966 when four daily soundings were obtained.

An 8-year (1969-1976) rocketsonde data sample, consisting of nonserially complete wind observations that decrease in number versus altitude, was used between 28 and 90 km for both sites. The number of rocket wind observations varied with month and especially with altitude. These data are presented up to 90 km altitude if more than two observations were available. Point Mugu, California, rocketsonde data were used for the Vandenberg 28 to 90 km statistics because it was the closest rocketsonde observational site to VAFB.

All wind data used in this study were originally recorded as vector winds (wind speed and corresponding direction). These vector winds were subsequently resolved into components along the azimuths α = 90 degrees and α = 360 degrees (true north).

Over the last 10 years the Meteorological Rocket Network (MRN) ranges have been measuring the upper atmosphere with instrumentation sent aloft by more powerful meteorological rockets, such as the Super Loki System. This allows for the measurement of the atmospheric properties in excess of 90 km altitude, which is far above the previously limiting altitude of approximately 60 km that had been attained by conventional Arcas and Loki type MRN rocket systems in the earlier days of high-altitude atmospheric data gathering. One item that the new MRN data show is that the altitude of maximum wind speed is a little higher than previously thought. The early MRN data seemed to indicate the altitude of max wind speed (above the jet-stream winds) band to be located between 55 and 60 km altitude, since observations were limited, and questionable, above the 60 km level at that time. The newer rocket wind data sample for these two sites indicates the peak to be located between the 62 and 65 km level for most months of the year. This is another reason for updating the winds-aloft information for the two sites.

DATA PRESENTED

From previous studies [1,2] it has been determined that the normal distribution provides a reasonable and adequate model for fitting surface and aloft wind components at KSC and VAFB locations. This bivariate normality

assumption is used in this report. The reader should consult these two references for more information on the type of normality statistical testing done.

The bivariate normal statistics for all months are presented in Tables 1.1 through 1.12 for KSC and in Tables 2.1 through 2.12 for VAFB. They are given for a 90-degree flight azimuth (α = 90 degrees), which is the standard meteorological notation that defines u as the zonal wind component (head-tail wind) and v as the meridional wind component (crosswind), where a positive (+) u indicates a wind from the west and a positive (+) v indicates a wind from the south. The wind components presented in this report are given in units of meters per second. Even though small wind data samples exist in the 70 to 90 km altitude interval, all the rocketsonde wind data are presented here, if more than two observations were available.

The monthly bivariate normal statistics are also plotted versus altitude in Figures 1.1 through 1.12 and Figures 2.1 through 2.12 for the KSC and VAFB locations, respectively. The figures associated with the proper tables are printed on successive pages in this report. The reader may notice the erratic, unrealistic behavior of the parameters [especially R(uv)] from time to time at these higher altitudes due to the low number of observations used. Erratic jumps, or spikes, noted in the figures between 27 and 28 km are due to the large decrease in data sample size (radiosonde to rocketsonde) that occurs at this level.

At mid-latitudes in the northern hemisphere easterly winds prevail throughout the upper stratosphere and mesosphere during the summer months, while westerly winds dominate the winter months[5.6]. This seasonal upper level circulation pattern change is the result of the changing thermal structure of the upper atmosphere, which establishes an anticyclone over the northern hemispheric summer pole and cyclonic flow around its winter pole. The transition months of approximately April and September may exhibit a slightly differing and somewhat erratic structure of rocket measured winds because this is a time of the winter westerly's changing over into the summer easterly regime (or vice-versa) at these altitudes. A typical winter to summer change-over in the upper-level wind field at KSC is shown and discussed in Reference 7. Using the five parameters at azimuth α = 90 degrees, the statistics for any rotation of axes of the bivariate normal surface may be obtained [4].

CONCLUSIONS

Care must be exercised in deciding which is a "best" model for a random variable. The question is not "Do the data come from some specified distribution?" because one can never be sure they do; but rather "Is some specified distribution a reasonable model for the description of the data?" If the physical constraints for the random variable are satisfied by a hypothetical distribution and after repeated sampling of this random variable it is found that the hypothetical distribution cannot be rejected by an appropriate statistical test, then one may reach the conclusion that this hypothetical distribution is an adequate model for the random variable under investigation.

Wind velocity components are variables that are unbounded at both ends. This constraint is satisfied by the normal distribution whose domain is from minus infinity to plus infinity. The use of the Gaussian model has a number of advantages. For example, if the wind components u and v are normally distributed, the scalar wind,

$$w = (u^2 + v^2)^{1/2} \quad ,$$

has a noncentral chi distribution. From a theoretical point of view, this property of the normal distribution illustrates one of its many advantages as a statistical model to represent random variables.

Winds-aloft information is presented in this report from 0 through 90 km altitude. Bivariate normal wind statistics involving wind probability distributions and statistics for any rotation of axes can be computed from the five given statistical parameters, $\bar{u}$, $\bar{v}$, S(u), S(v), and R(uv) for a 90-degree flight azimuth, because it had been previously determined that the normal distribution provides an adequate model for wind components at KSC and VAFB.

Bivariate normal wind statistics are also available from 0 to 27 km altitude for the Edwards AFB/NASA-Dryden Flight Research Center, California, as presented in Reference 8. The 28 to 90 km altitude Vandenberg AFB wind statistics given in this report can be used for the >27-km altitude region at Edwards AFB.

TABLE 1.1. KSC BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

January

Alt (km)	ū	v̄	S(u)	S(v)	R(uv)	N
0	48	- 66	2 90	3 35	- 2478	1178
1	2 51	1 09	6 74	6 21	- 0090	1178
2	6 52	1 28	6 92	6 21	0040	1178
3	10 13	1 41	7 36	6 96	0455	1178
4	13 59	1 81	8 19	7 62	0946	1178
5	17 13	2 25	9 17	8 42	1367	1178
6	20 56	2 84	10 00	9 28	1728	1178
7	23 89	3 42	11 21	10 49	2202	1178
8	27 16	3 72	12 39	11 44	2871	1178
9	30 50	3 95	13 77	12 31	2828	1178
10	33 93	4 26	15 23	13 09	3266	1178
11	37 43	4 43	16 16	14 08	3253	1178
12	40 00	4 68	15 49	13 99	3250	1178
13	40 55	4 56	13 85	12 27	3669	1178
14	38 50	4 97	12 52	10 53	3043	1178
15	34 39	3 84	10 97	9 85	2904	1178
16	29 51	3 52	9 59	8 34	2602	1178
17	23 63	2 70	8 76	7 23	2473	1178
18	17 61	1 95	7 96	5 79	2693	1178
19	12 20	1 21	7 39	4 93	2596	1178
20	8 39	72	6 85	3 85	2915	1178
21	6 26	43	6 99	3 65	2243	1178
22	5 24	37	7 46	3 77	2612	1178
23	4 76	46	7 99	3 92	2781	1178
24	4 81	44	8 75	3 93	2822	1178
25	5 55	49	9 34	4 26	2392	1178
26	6 64	66	10 07	4 63	2540	1178
27	7 18	1 11	12 17	5 32	1982	1178
28	7 3	1 51	10 42	4 94	0251	110
29	8 75	2 16	10 75	5 05	0477	111
30	10 65	2 54	11 54	6 28	0080	112
31	12 30	3 01	12 49	6 25	0379	113
32	15 32	3 12	13 45	6 81	0417	115
33	17 36	3 00	14 09	7 26	0719	114
34	18 77	1 91	15 00	7 73	0993	116
35	18 60	52	15 66	7 90	0454	114
36	16 92	05	15 95	8 39	0234	113
37	15 89	77	16 83	9 36	0436	116
38	15 99	1 86	17 05	9 32	1130	116
39	15 85	2 01	16 79	9 65	2622	117
40	15 17	2 81	17 62	8 71	2300	121
41	14 14	3 46	18 94	9 40	1830	119
42	13 46	4 14	19 51	10 90	0985	120
43	13 14	5 80	19 88	11 54	0801	119
44	11 92	9 18	20 24	12 22	1258	119
45	11 29	10 07	20 44	12 38	1068	119
46	10 93	9 69	20 96	13 18	1248	122
47	11 01	9 12	21 63	12 72	1926	118
48	11 50	9 18	22 66	12 85	1302	118
49	12 96	9 14	22 74	13 89	0699	112
50	14 26	9 53	22 62	14 61	1061	115
51	15 90	10 25	22 43	15 12	0850	117
52	16 93	8 45	22 52	13 50	0635	112
5_	18 10	8 47	22 24	14 78	1082	109
54	19 71	9 81	22 67	14 98	1170	103
55	22 55	11 56	23 50	15 9	0854	98
56	24 84	10 96	24 03	15 34	0879	94
57	30 42	12 12	24 51	14 35	1306	92
58	34 60	14 05	22 84	13 33	2026	87
59	37 27	15 48	21 99	13 88	2229	75
60	41 26	14 66	22 64	14 11	3305	61
61	46 13	14 21	21 92	13 91	3324	53
62	51 54	12 11	23 14	15 68	3410	46
63	54 53	9 58	24 03	16 65	2668	36
64	54 18	5 69	27 16	16 96	3344	39
65	58 26	77	28 83	17 03	4064	35
66	57 62	-1 91	31 17	18 36	2881	34
67	59 16	-5 13	33 38	17 51	3368	31
68	55 06	-10 73	32 91	18 93	1369	33
69	56 12	-16 18	36 82	20 32	- 0187	34
70	54 76	-19 06	40 28	21 12	0343	24
71	49 88	-22 62	46 67	21 66	0678	24
72	41 63	-21 57	39 87	22 67	0853	30
73	42 19	-17 81	35 60	25 20	- 1158	26
74	39 67	-13 96	37 27	27 34	- 0566	24
75	35 85	-14 95	35 58	26 36	3314	24
76	33 37	-5 42	36 35	25 42	2838	19
77	30 68	1 53	36 72	24 43	4423	19
78	29 74	8 26	36 61	24 70	3869	19
79	30 63	14 32	34 87	24 97	3584	19
80	31 28	19 83	33 90	24 98	3812	18
81	33 90	23 78	32 95	25 16	3651	18
82	36 61	26 67	32 79	25 76	3398	18
83	37 94	28 13	34 44	27 93	3303	16
84	38 47	26 00	33 91	27 31	1954	15
85	37 67	20 33	34 66	30 85	0102	12
86	44 87	29 00	38 96	38 23	- 1979	8
87	26 20	41 20	27 17	32 84	6138	5
88	25 40	43 60	27 82	34 64	6068	5
89	24 60	44 40	26 48	33 77	6346	5
90	22 20	42 00	24 36	30 11	9591	5

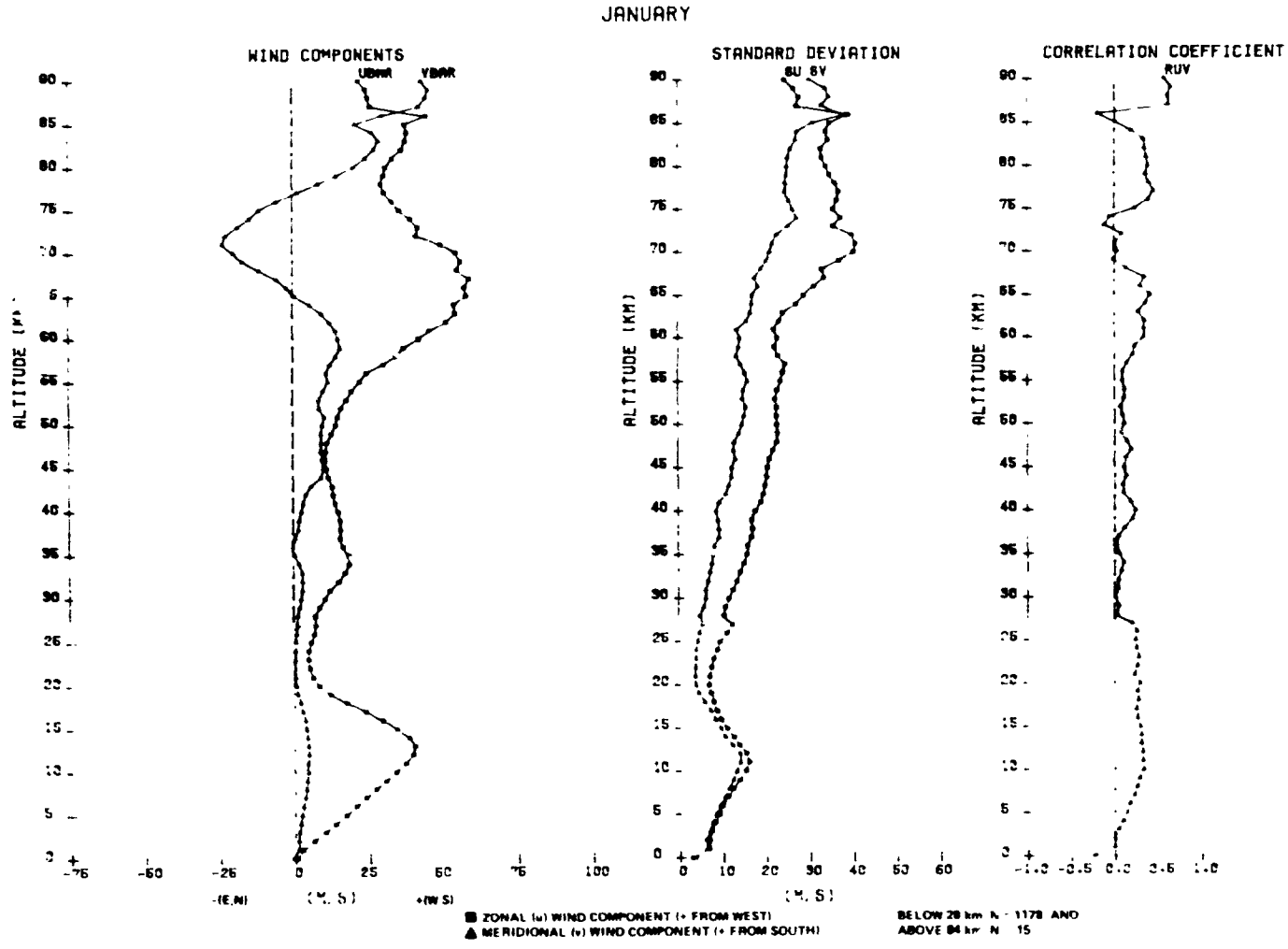

Figure 1.1. KSC bivariate normal wind statistics, 90 degree flight azimuth.

Table 1.2. KSC BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

February

Alt (km)	$\bar{u}$	$\bar{v}$	S(u)	S(v)	R(uv)	N
0	65	- 21	3 28	3 68	- 2615	1074
1	3 70	1 62	7 17	6 80	- 0277	1074
2	7 88	1 48	7 74	6 82	0083	1074
3	11 70	1 68	8 20	7 40	0437	1074
4	15 21	2 10	9 11	8 10	0338	1074
5	18 97	2 49	10 16	8 98	0501	1074
6	22 95	2 98	11 14	9 62	1124	1074
7	26 58	3 31	12 43	10 48	1653	1074
8	30 23	3 40	13 80	11 54	1991	1074
9	34 26	3 50	15 38	12 64	2148	1074
10	38 18	3 39	16 45	13 89	2159	1074
11	42 13	3 32	17 08	14 91	2281	1074
12	44 84	3 49	16 53	14 36	2267	1074
13	44 76	3 52	15 06	12 85	2863	1074
14	41 65	3 33	13 08	11 05	2759	1074
15	36 73	2 90	11 45	9 28	2660	1074
16	31 59	2 60	10 27	8 25	1485	1074
17	25 36	1 94	9 20	7 04	1429	1074
18	18 78	1 41	8 49	5 67	2378	1074
19	12 77	99	7 84	4 52	2280	1074
20	7 85	63	7 40	3 89	2540	1074
21	5 21	18	7 26	4 23	2321	1074
22	4 04	- 14	7 66	4 11	2344	1074
23	3 47	- 02	7 87	4 10	2736	1074
24	3 65	09	8 27	3 89	2797	1074
25	3 88	- 02	9 15	3 85	3470	1074
26	4 48	11	9 82	4 09	3675	1074
27	5 14	35	10 57	4 13	2259	1074
28	9 08	3 22	9 48	4 85	2951	79
29	10 78	3 67	9 42	5 67	2540	79
30	12 53	4 18	9 91	6 03	3252	77
31	14 63	4 15	10 65	6 80	3548	81
32	16 83	3 73	11 72	6 39	3957	81
33	18 41	2 85	12 90	6 36	3947	81
34	18 41	1 51	13 55	6 31	3675	81
35	17 61	38	14 31	6 10	3274	85
36	16 64	- 96	14 59	6 74	2480	85
37	15 13	- 45	15 13	7 87	2802	87
38	14 47	23	15 83	7 59	2648	87
39	13 94	18	16 79	8 00	1863	88
40	12 71	94	18 33	8 39	1776	87
41	11 60	2 74	18 69	7 60	0952	88
42	11 82	3 63	18 82	7 55	0531	89
43	13 25	5 08	18 76	8 96	1419	89
44	13 86	5 74	18 75	9 34	1513	86
45	14 87	6 27	19 63	10 11	1188	88
46	16 49	7 30	20 52	10 88	1161	90
47	18 46	8 75	20 73	10 76	0906	89
48	18 87	8 83	21 28	11 22	0649	89
49	19 98	9 23	21 02	11 23	0061	88
50	21 35	9 57	21 49	12 30	0203	88
51	22 91	9 72	21 19	12 61	1194	85
52	25 42	9 51	21 33	12 36	0854	84
53	28 18	9 16	20 59	12 27	1107	82
54	30 62	8 99	19 63	13 02	1702	82
55	34 27	11 12	18 00	13 33	1582	82
56	38 00	12 25	18 41	13 41	1751	80
57	41 51	13 97	18 57	12 58	1623	79
58	45 58	15 42	17 90	11 80	2153	66
59	48 06	16 24	18 17	12 11	2007	63
60	49 71	15 19	18 69	12 01	0992	59
61	54 11	14 82	18 95	11 80	2973	44
62	57 36	13 09	19 38	11 85	2644	33
63	58 44	10 28	18 68	11 33	- 0387	32
64	60 36	6 82	15 37	10 89	- 0402	28
65	59 89	3 50	15 01	11 49	0436	28
66	60 07	- 26	15 83	12 08	- 0695	27
67	60 64	-5 68	15 12	13 12	- 2037	25
68	59 52	-5 70	16 42	9 90	- 0087	23
69	56 48	-8 22	16 75	11 44	1063	23
70	50 92	-12 81	18 49	13 25	0056	21
71	42 76	-14 81	19 21	13 63	1244	21
72	37 11	-15 58	20 49	13 61	3917	19
73	30 11	-11 11	21 77	12 79	4381	19
74	24 20	-8 55	23 75	13 37	1233	20
75	19 25	-5 76	22 79	16 99	- 0194	20
76	13 78	- 28	21 72	19 80	1905	18
77	11 94	5 87	20 09	22 48	2601	16
78	8 31	10 81	20 44	23 17	3862	16
79	6 75	15 69	20 60	22 81	4347	16
80	6 37	18 87	20 72	22 49	4223	16
81	5 81	21 56	21 39	22 65	3534	16
82	5 37	23 12	22 95	23 44	2424	16
83	6 93	26 47	25 31	22 52	0293	15
84	4 93	25 43	29 40	25 08	- 0659	14
85	5 27	30 66	28 65	27 99	- 1226	11
86	8 20	25 20	12 45	27 20	8446	5

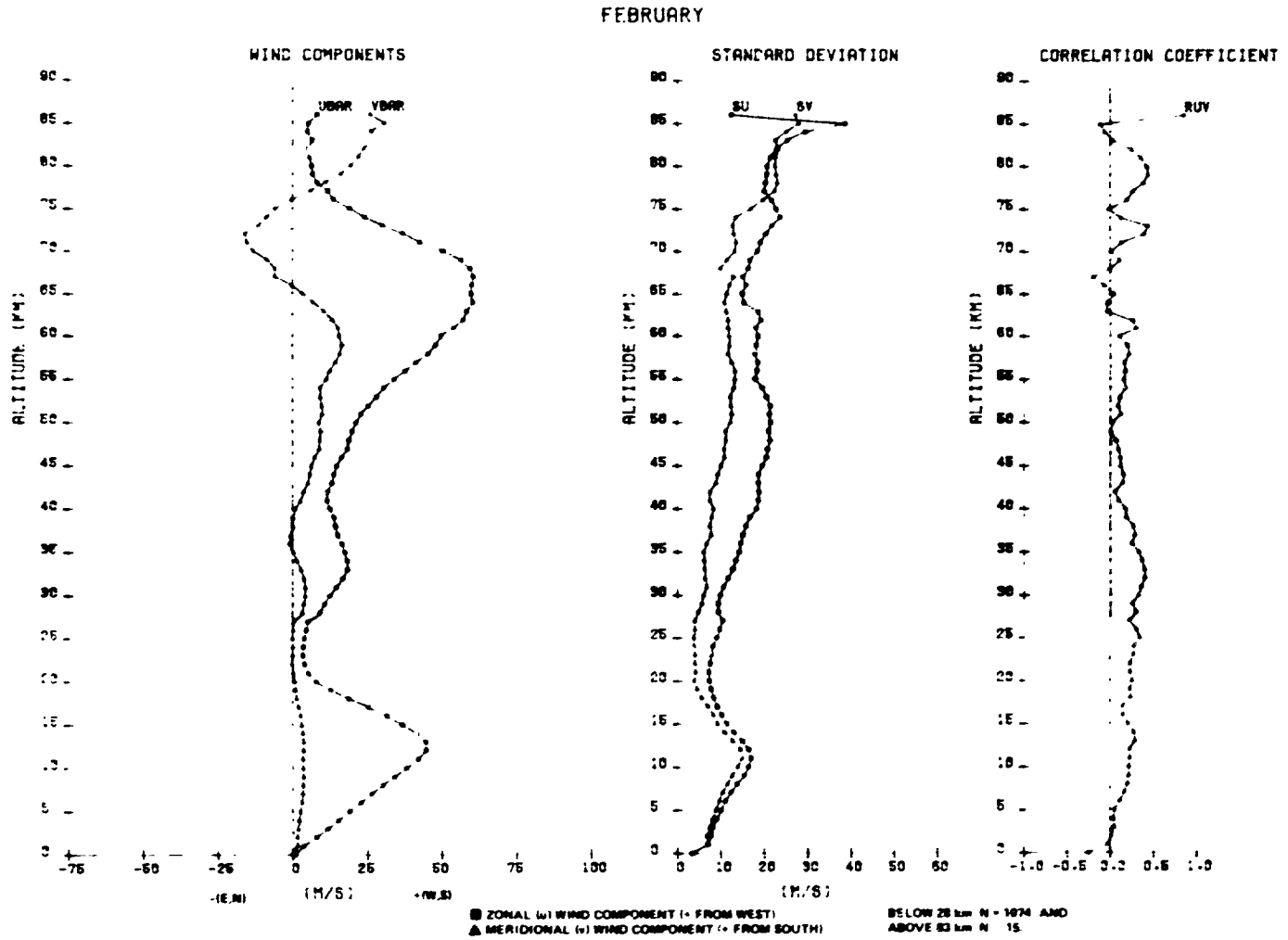

Figure 1.2. KSC bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 1.3. KSC BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

March

Alt (km)	$\bar{u}$	$\bar{v}$	S(u)	S(v)	R(uv)	N
0	09	14	3 24	3 39	- 1812	1178
1	3 13	1 64	7 00	6 26	0120	1178
2	7 10	1 31	7 43	6 19	0481	1178
3	10 51	1 18	8 42	6 58	0828	1178
4	14 00	85	9 38	7 26	0842	1178
5	17 71	75	10 32	7 79	1530	1178
6	21 50	91	11 27	8 52	1945	1178
7	25 15	1 12	12 30	9 44	2265	1178
8	28 67	1 16	13 35	10 25	2321	1178
9	32 40	98	14 60	11 70	2076	1178
10	36 29	75	15 92	13 21	1882	1178
11	40 13	43	16 41	14 75	1707	1178
12	43 15	51	15 67	14 49	2021	1178
13	43 49	90	13 85	12 71	2078	1178
14	40 29	98	12 32	10 28	1618	1178
15	35 35	1 07	10 69	8 9.	1354	1178
16	29 74	88	9 29	7 78	0869	1178
17	23 48	98	8 49	6 78	0589	1178
18	16 87	74	7 72	5 56	1034	1178
19	10 55	52	6 79	4 52	1170	1178
20	6 17	24	6 32	3 89	0998	1178
21	3 38	- 13	5 92	3 58	0642	1178
22	1 86	- 27	6 01	3 63	0671	1178
23	83	- 51	6 08	3 56	0771	1178
24	59	- 68	6 44	3 61	1013	1178
25	90	- 83	7 14	3 41	1206	1178
26	1 73	- 83	7 89	3 35	1135	1178
27	2 45	- 68	9 01	3 64	1057	1178
28	6 01	1 59	8 20	3 38	3503	92
29	8 03	1 67	8 84	3 41	2966	93
30	10 37	2 15	9 30	3 78	3574	91
31	12 44	2 33	9 73	3 82	4719	96
32	14 24	2 19	10 40	4 1	4834	97
33	15 87	1 56	11 83	4 95	4360	96
34	16 93	30	13 08	5 08	2604	96
35	15 92	- 94	13 89	5 31	1167	95
36	13 96	-1 64	14 25	5 48	0197	95
37	12 30	- 98	14 18	5 64	0349	94
38	11 56	- 06	13 81	5 47	1910	94
39	11 77	96	15 08	6 26	3992	95
40	12 02	1 96	16 12	6 59	3252	98
41	12 27	2 42	17 14	6 35	3006	97
42	12 89	3 08	17 97	7 13	2792	97
43	13 93	2 93	19 00	7 15	1699	100
44	13 65	3 41	18 75	7 26	0340	101
45	14 53	4 04	19 94	7 47	0044	100
46	15 48	5 29	20 25	8 42	0195	.04
47	16 45	5 83	20 31	7 68	0398	102
48	18 00	7 00	20 25	7 22	0898	102
49	20 19	7 77	19 71	7 38	0490	100
50	21 65	7 76	20 20	7 96	1261	101
51	22 80	7 10	20 54	7 94	- 0039	98
52	24 52	7 89	20 15	9 23	0116	96
53	26 23	7 86	20 43	9 54	- 0663	96
54	26 61	8 28	19 90	9 82	- 0586	92
55	28 53	9 00	20 64	9 30	0415	91
56	29 22	9 73	20 38	9 31	0882	86
57	30 34	9 64	20 36	9 28	1276	86
58	31 70	10 34	20 92	9 53	1674	76
59	32 74	11 82	20 65	9 92	1847	65
60	35 64	12 33	20 60	12 00	1205	55
61	37 02	10 70	21 67	13 56	1035	44
62	35 66	9 82	23 03	13 47	- 0116	38
63	36 77	10 00	24 53	13 05	1209	31
64	34 22	8 07	23 62	12 74	1602	27
65	34 92	6 69	22 57	11 96	0796	26
66	31 45	4 59	22 45	9 61	1483	22
67	30 12	00	19 75	10 88	3029	17
68	27 24	06	20 81	13 37	0820	17
69	23 11	-1 68	21 40	15 15	0351	19
70	20 11	-2 32	20 78	16 42	0043	19
71	16 44	-6 67	20 71	17 98	0645	18
72	9 79	-6 37	20 93	16 53	0828	19
73	4 94	-6 47	21 27	16 56	0023	17
74	3 50	-4 19	21 36	18 09	1967	16
75	-5 29	-4 79	17 21	17 21	- 0579	14
76	-9 62	- 54	16 11	16 61	- 0662	13
77	-13 54	2 54	15 23	17 13	- 0178	13
78	-16 46	6 54	14 23	18 22	0167	13
79	-17 75	7 50	13 66	15 52	1868	12
80	-18 15	15 92	12 70	21 08	2704	13
81	-17 25	21 75	13 98	22 65	4290	12
82	-13 27	25 73	16 72	24 48	6350	11
83	-11 70	23 80	20 13	19 64	6615	10
84	-8 36	27 27	23 42	19 41	5913	11
85	-5 40	26 90	29 52	20 47	3857	10
86	-5 20	23 20	14 36	17 13	2710	5
87	-6 00	24 00	13 37	17 66	8979	3

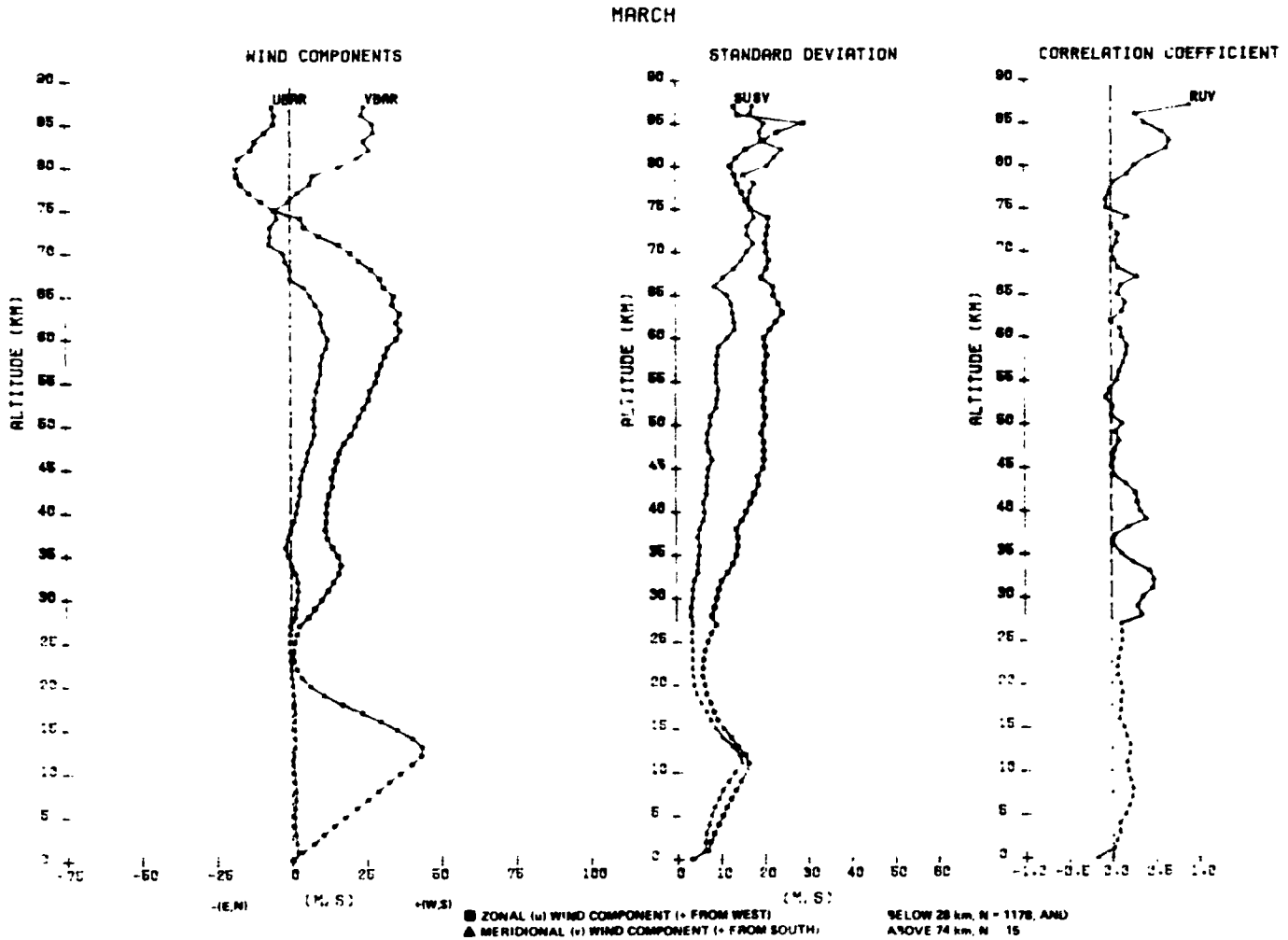

Figure 1.3. KSC bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 1.4. KSC BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

April

A (km)	$\bar{u}$	$\bar{v}$	S(u)	S(v)	R(uv)	N
0	- 96	51	3 31	3 15	- 1161	1140
1	1 05	1 25	6 72	5 28	0004	1140
2	3 72	36	7 22	5 26	1083	1140
3	6 10	- 50	8 01	5 97	0967	1140
4	8 65	-1 13	8 78	6 63	1598	1140
5	11 21	-1 47	9 69	7 00	2654	1140
6	14 01	-1 72	10 61	7 55	2329	1140
7	16 90	-2 02	11 62	8 45	2646	1140
8	19 80	-2 38	12 77	9 36	2787	1140
9	22 48	-2 81	14 26	10 63	2976	1140
10	25 *	-3 49	15 37	12 23	3302	1140
11	28 98	-4 21	16 35	13 78	3149	1140
12	32 17	-4 73	16 66	14 65	3218	1140
13	34 10	-4 88	15 83	13 86	3351	1140
14	32 18	-4 36	13 92	11 95	3433	1140
15	28 26	-3 41	11 63	9 69	3215	1140
16	23 34	-2 96	9 84	8 31	2881	1140
17	17 50	-2 37	8 79	6 95	2776	1140
18	11 03	-1 88	7 53	5 42	2535	1140
19	5 38	-1 19	6 68	4 32	2510	1140
20	1 73	- 87	5 68	3 90	2005	1140
21	- 40	- 93	4 86	3 22	1770	1140
22	-1 78	- 75	4 60	2 98	1215	1140
23	-2 48	- 69	4 72	2 91	0651	1140
24	-2 56	- 74	5 14	2 96	1319	1140
25	-2 19	- 84	5 73	3 07	1932	1140
26	-1 61	- 80	6 53	3 16	1858	1140
27	- 72	- 78	7 09	3 24	1147	1140
28	2 25	1 47	6 83	3 41	- 0306	91
29	4 01	1 72	7 53	3 78	0481	93
30	4 62	1 51	8 03	4 19	2366	93
31	5 61	1 78	8 93	4 11	3173	97
32	6 69	1 03	9 89	4 37	2917	98
33	7 00	56	11 03	4 39	2544	97
34	7 59	33	11 79	4 91	1666	98
35	7 39	- 95	12 59	4 86	0102	98
36	6 71	-1 01	12 41	4 99	- 0753	97
37	6 30	-1 37	11 97	6 16	- 0897	98
38	5 62	-1 90	11 45	6 43	- 0502	99
39	4 64	- 94	11 57	6 06	0323	100
40	4 51	51	11 14	6 14	1053	101
41	4 61	89	11 17	6 18	1498	103
42	4 87	1 15	10 70	6 48	1095	104
43	4 18	46	11 31	6 67	1886	103
44	3 42	62	11 44	5 92	1942	104
45	2 3	1 91	11 42	6 46	0268	104
46	2	2 81	12 05	6 87	0067	102
47	1 37	3 25	11 95	7 40	1032	102
48	1 96	3 84	12 25	7 16	1033	103
49	2 44	4 97	12 95	7 80	1496	103
50	2 43	4 19	13 58	6 76	0691	102
51	2 32	4 34	14 00	7 02	0318	103
52	1 98	4 45	14 59	7 27	0701	101
53	1 55	4 60	14 52	6 55	0716	102
54	99	4 62	14 27	6 69	0255	96
55	1 23	4 78	14 34	7 31	- 0137	93
56	64	4 86	13 33	7 51	0754	90
57	58	5 52	13 22	8 24	0316	88
58	77	6 08	13 17	7 92	0809	79
59	1 12	4 96	15 09	8 48	2232	74
60	1 21	4 38	15 90	8 50	1419	66
61	1 88	3 78	15 34	8 04	0765	58
62	3 64	5 89	15 75	7 86	- 0953	45
63	4 85	7 38	15 84	8 57	0133	39
64	1 86	6 60	17 29	9 79	0108	35
65	**	3 00	16 26	10 64	0704	33
66	34	- 97	15 62	11 64	0241	32
67	-1 93	-4 27	16 28	11 10	2316	30
68	-5 23	-6 38	17 35	10 76	2089	26
69	-7 73	-7 54	18 22	11 19	- 0838	26
70	-10 63	-7 41	15 85	13 33	- 2024	27
71	-12 28	-8 04	15 25	16 86	- 1388	25
72	-13 22	-7 83	15 60	17 94	- 1107	23
73	-13 83	7 04	18 59	17 43	0965	23
	-14 06	-6 25	20 45	13 04	0625	16
75	-15 40	-8 67	18 65	15 25	- 0162	15
76	-24 18	-8 00	17 39	18 33	3018	11
77	-27 64	-4 64	19 20	20 40	3257	11
78	-30 73	-2 09	17 08	20 65	2982	11
79	-35 00	-4 30	14 14	19 14	- 1286	10
80	-35 80	- 70	12 94	20 92	- 0653	10
81	-35 00	3 70	13 45	21 64	0656	10
82	- 2 70	9 70	15 26	21 63	2381	10
83	-28 30	16 00	17 50	22 16	3557	10
84	-22 10	21 30	20 24	21 33	4222	10
85	-8 00	28 57	24 83	8 36	5055	7
86	9 75	31 25	33 38	7 82	4292	4

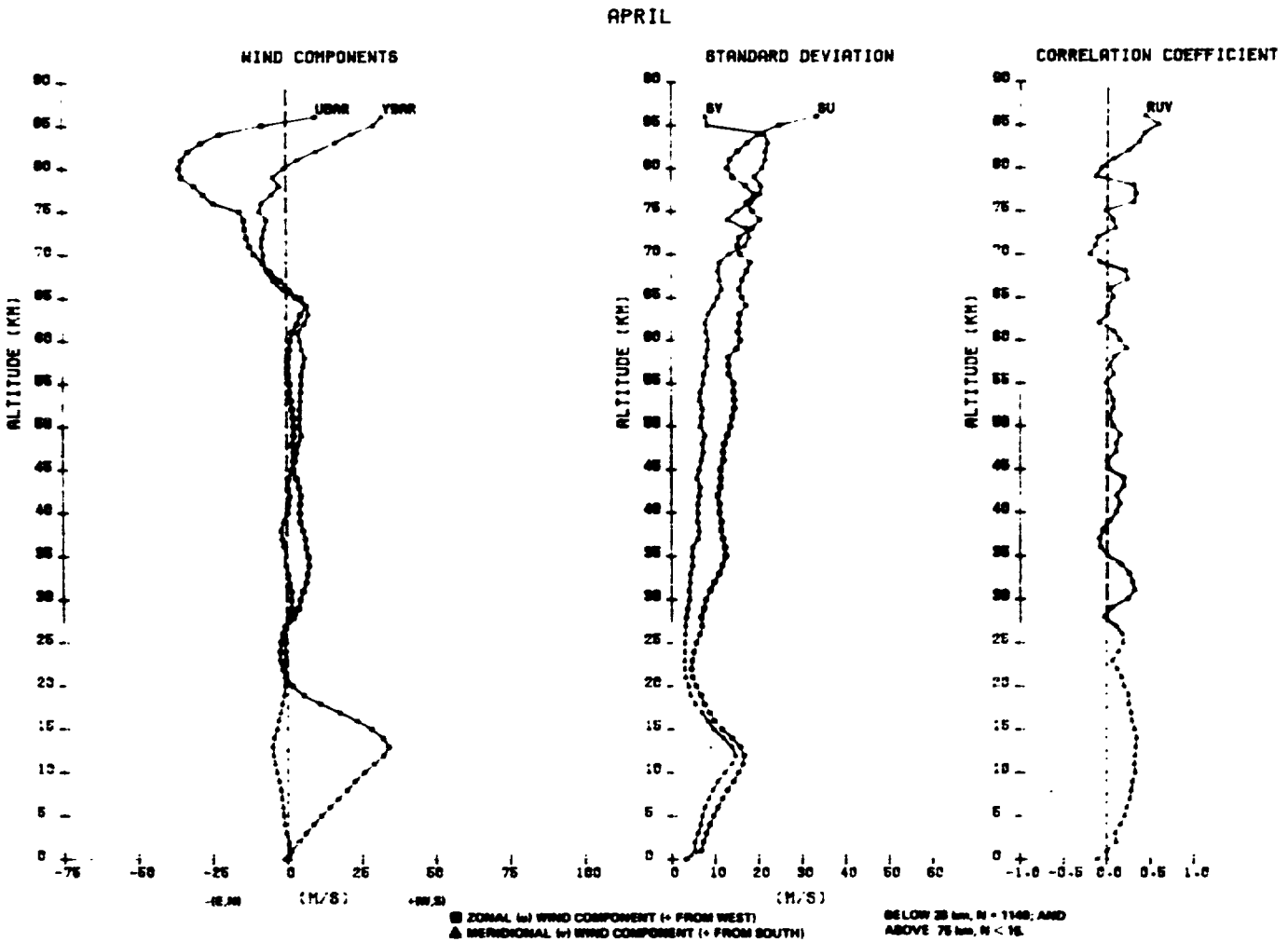

Figure 1.4. KSC bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 1.5. KSC BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

May

Alt (km)	$\bar{u}$	$\bar{v}$	S(u)	S(v)	R(uv)	N
0	-1 38	61	2 95	2 57	- 0608	1178
1	- 52	1 17	5 29	4 31	1159	1178
2	1 00	21	5 76	4 57	2758	1178
3	2 33	- 01	6 13	4 81	2621	1178
4	3 67	- 20	6 71	5 25	2253	1178
5	5 23	- 42	7 12	5 74	2299	1178
6	6 90	- 57	7 66	6 54	2265	1178
7	8 60	- 62	8 37	7 36	2379	1178
8	10 27	- 57	9 36	8 30	2129	1178
9	11 99	- 66	10 37	9 63	2152	1178
10	14 07	- 79	11 73	11 08	2292	1178
11	16 69	-1 04	12 97	12 68	2608	1178
12	19 51	-1 64	14 21	13 88	2787	1178
13	21 98	-2 83	14 20	13 87	2861	1178
14	20 99	-3 25	12 51	11 98	3034	1178
15	17 78	-3 34	10 29	9 42	3446	1178
16	13 30	-3 04	8 51	7 35	3307	1178
17	8 30	-2 69	7 02	5 82	3271	1178
18	3 69	-2 02	5 91	4 54	2636	1178
19	- 04	-1 36	4 79	3 61	2053	1178
20	-2 60	-1 10	4 30	2 93	1434	1178
21	-4 51	- 75	4 08	2 66	0186	1178
22	-5 73	- 62	4 16	2 69	- 0296	1178
23	-6 50	- 44	4 22	2 71	- 0166	1178
24	-6 94	- 40	4 56	2 80	0234	1178
25	-6 96	- 53	5 00	2 78	0023	1178
26	-6 88	- 53	5 43	2 84	0165	1178
27	-6 64	- 48	5 87	2 96	0072	1178
28	-5 55	48	6 12	2 76	1640	75
29	-5 24	- 16	6 52	2 90	- 0324	75
30	-5 37	- 18	6 75	3 14	- 0019	78
31	-5 35	18	7 03	3 49	- 0602	78
32	-5 24	1 13	7 45	3 62	- 0254	78
33	-4 18	1 44	8 09	3 88	0897	79
34	-3 49	91	7 69	3 81	0483	78
35	-3 41	00	7 68	3 48	1170	78
36	-4 77	- 65	7 85	3 01	1355	78
37	-6 47	-1 08	8 08	4 04	- 0704	77
38	-7 46	- 50	7 75	4 35	- 1057	78
39	-7 95	16	7 21	4 20	- 1345	77
40	-9 05	08	6 71	4 32	- 1995	77
41	-10 29	- 15	6 99	4 34	0281	78
42	-12 65	- 26	7 20	4 80	0437	78
43	14 50	54	6 97	4 77	- 0851	80
44	-16 94	49	7 04	5 76	0099	81
45	-18 92	1 92	7 09	5 31	0444	83
46	-19 81	2 57	7 59	5 39	0804	83
47	-19 99	3 04	7 88	5 78	0715	82
48	-20 91	2 52	8 60	5 81	0862	82
49	-21 98	3 73	9 08	6 12	0447	81
50	-23 26	4 64	9 19	5 69	- 0315	80
51	-24 44	4 60	9 45	5 75	- 1220	78
52	-25 61	4 77	9 69	6 26	- 0291	77
53	-26 58	5 36	10 12	6 69	0169	78
54	-26 47	6 42	10 67	7 02	- 0452	79
55	-25 85	6 23	10 21	7 56	- 0769	73
56	-26 30	5 19	10 22	7 36	- 0243	70
57	-26 82	6 01	10 80	7 32	0448	68
58	-27 08	5 91	10 99	8 96	0694	64
59	-28 43	5 43	10 75	8 33	0558	58
60	-29 60	4 62	11 19	7 58	0496	48
61	-30 45	4 38	11 49	7 79	0921	40
62	-29 25	3 46	12 04	10 23	0412	28
63	-28 92	3 50	12 46	11 13	0352	26
64	-28 73	4 08	12 77	11 36	- 0097	26
65	-31 70	4 13	15 01	9 60	- 0941	23
66	-26 10	6 19	16 95	20 35	4784	21
67	-29 50	2 10	16 82	19 29	3948	20
68	-32 79	-2 16	16 27	10 45	- 0958	19
69	-34 12	-8 06	16 22	13 51	2383	16
70	-38 93	-12 00	18 14	14 67	5859	15
71	-42 40	-12 40	14 30	15 15	4448	10
72	-42 20	-7 30	13 99	16 81	4355	10
73	-39 90	-5 80	15 42	21 25	4802	10
74	-35 40	2 70	18 54	45 43	5008	10
75	-32 75	1 00	23 60	42 65	2961	8
76	-34 75	-1 00	23 67	33 87	0257	8
77	-40 86	-9 14	23 41	20 05	- 2521	7
78	-26 29	-24 86	15 60	20 38	6153	7
79	-20 86	-25 57	14 91	21 69	4884	7
80	-20 57	-23 57	20 68	22 96	4503	7
81	-19 57	-20 14	27 54	26 56	1934	7
82	-18 29	-14 43	35 03	31 96	- 0648	7
83	-16 87	-6 75	38 86	35 11	- 2564	8
84	-15 37	- 25	42 13	38 20	- 4373	8
85	-16 29	4 86	45 98	42 11	- 7053	7
86	-9 00	20 67	48 95	45 29	- 9694	6
87	-17 50	45 50	54 06	52 98	- 9629	4
88	-12 50	48 25	54 80	57 49	- 9378	4
89	22 00	11 00	13 17	12 01	9620	3
90	26 33	8 67	17 00	13 [illegible]	9991	3

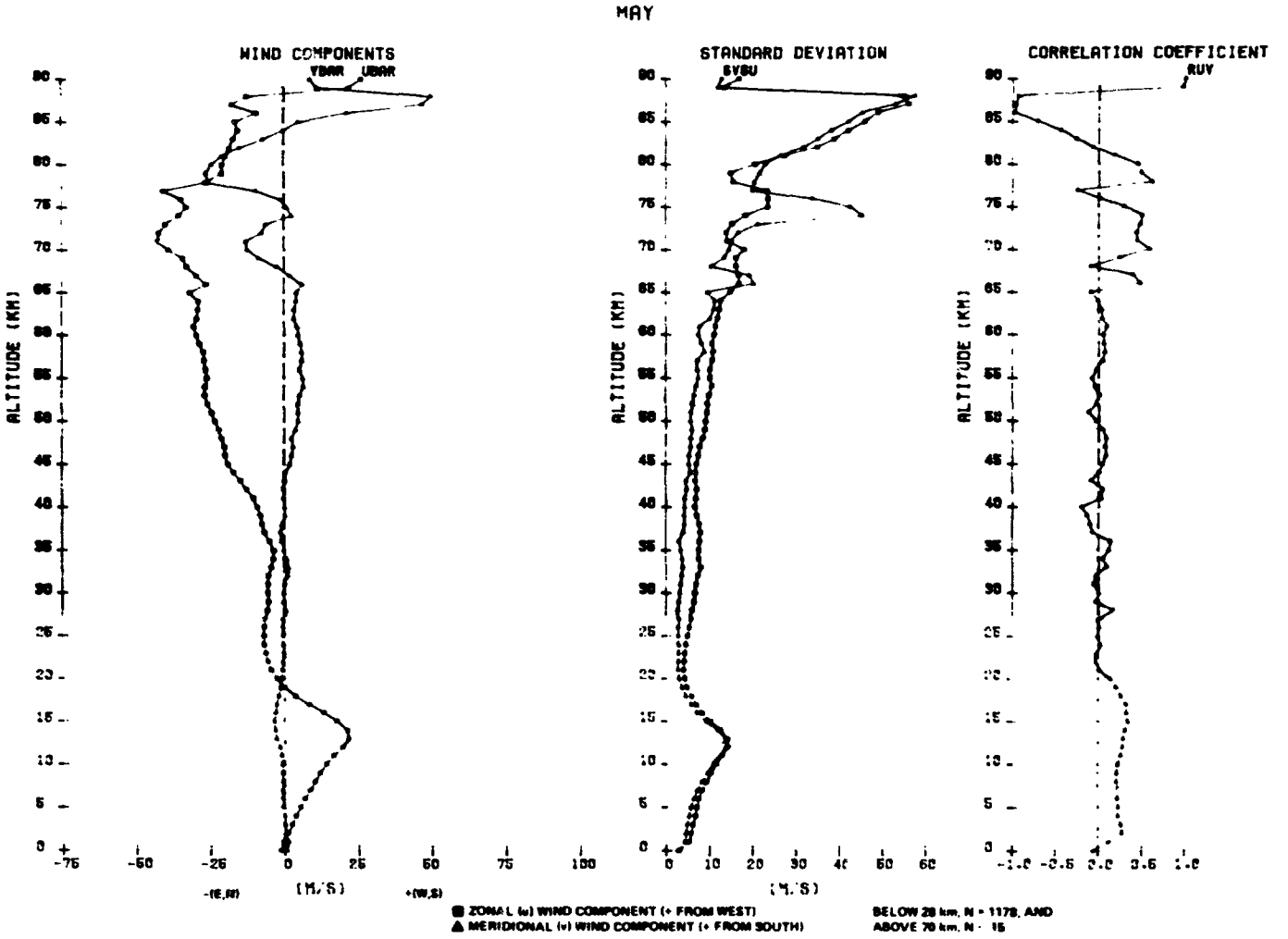

Figure 1.5. KSC bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 1.6. KSC BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

June

Alt (km)	ū	v̄	S(u)	S(v)	R(uv)	N
0	- 88	1 01	2 84	2 38	0319	1140
1	35	1 76	5 37	4 05	1202	1140
2	1 33	1 15	5 29	4 37	1420	1140
3	1 91	96	5 28	4 51	1009	1140
4	2 34	79	5 46	4 62	1012	1140
5	2 70	45	5 71	4 69	0993	1140
6	3 09	06	6 04	4 93	1718	1140
7	3 76	- 09	6 64	5 26	2282	1140
8	4 43	- 15	7 34	5 88	2372	1140
9	5 36	- 21	8 48	6 88	2706	1140
10	6 13	- 38	9 78	8 18	2934	1140
11	6 93	- 59	11 08	9 44	3318	1140
12	8 96	-1 36	12 45	10 71	3401	1140
13	8 78	-2 73	13 09	10 86	3254	1140
14	7 88	-4 07	12 22	9 38	2995	1140
15	5 56	-4 81	10 20	7 13	2207	1140
16	2 24	-4 03	7 50	5 32	1735	1140
17	- 98	-2 97	5 55	4 18	1565	40
18	-4 00	-2 06	4 39	3 16	1203	1140
19	-6 49	-1 33	3 85	2 77	[illegible]	1140
20	-8 62	-1 07	3 88	2 69	[illegible]	1140
21	-10 25	- 74	3 82	2 85	- 0845	1140
22	-11 61	- 52	3 70	3 08	- 1095	1140
23	-12 66	- 32	3 91	3 00	- 0540	1140
24	-13 35	- 21	4 19	2 81	- 0618	1140
25	-13 86	- 33	4 49	2 85	- 0842	1140
26	-14 16	- 47	4 73	3 04	- 0764	1140
27	-14 43	- 68	5 11	3 11	- 0827	1140
28	-16 01	- 03	5 07	2 29	0354	90
29	-16 55	25	5 32	2 27	- 0424	88
30	-17 11	87	5 24	2 96	- 0837	91
31	-17 15	1 27	5 50	3 26	- 1467	92
32	-16 75	1 41	5 83	3 35	- 1823	91
33	-16 97	89	5 98	3 76	- 1027	93
34	-17 34	38	6 61	3 57	- 1125	93
35	-18 66	- 49	6 51	3 72	- 2093	91
36	-20 32	- 98	6 15	3 93	- 1765	88
37	-22 26	-1 02	5 79	4 13	- 0921	88
38	-24 49	- 56	5 90	4 45	0959	87
39	-26 67	- 56	5 96	4 31	0226	87
40	-28 60	- 40	5 99	4 69	0544	86
41	-30 57	-1 45	7 11	4 45	0030	88
42	-33 20	-1 41	7 99	4 61	1109	91
43	-36 00	- 98	8 43	5 09	0312	91
44	-38 49	09	8 29	5 42	0311	93
45	-39 77	1 95	8 01	5 24	0482	93
46	-40 85	3 93	7 56	5 49	0013	94
47	-41 24	5 78	7 76	5 97	0717	91
48	-41 07	6 86	8 25	6 53	1253	92
49	-41 02	7 28	8 81	6 35	1105	92
50	-41 02	7 73	9 93	7 09	0379	90
51	-41 73	6 86	9 67	7 27	- 0961	95
52	-42 88	6 43	8 80	7 83	- 0131	94
53	-44 19	5 23	9 11	8 45	- 0497	93
54	-45 68	4 67	9 22	8 76	- 0451	93
55	-47 80	3 76	10 21	9 32	- 0151	89
56	-49 30	3 07	11 59	9 91	- 0017	89
57	-50 66	3 51	12 17	10 49	- 0629	86
58	-51 71	2 71	13 46	10 55	- 0847	79
59	-51 76	2 12	11 84	10 74	- 1917	72
60	-53 18	1 57	11 50	11 16	- 1068	65
61	-56 81	28	13 35	12 33	- 1163	54
62	-59 40	23	15 02	13 30	- 1803	43
63	-59 39	1 84	14 14	15 45	- 0094	38
64	-59 22	2 33	16 04	16 51	1649	36
65	-56 80	3 13	22 54	15 85	2677	30
66	-53 85	31	23 05	17 28	2095	26
67	-53 96	26	20 98	17 83	1777	23
68	-56 06	3 00	21 46	17 43	2485	17
69	-57 42	8 89	17 72	17 98	2889	19
70	-54 79	7 79	19 21	18 70	3891	19
71	-50 67	3 94	16 44	18 35	4269	18
72	-45 89	-1 05	16 72	17 23	5678	19
73	-45 81	-8 94	21 20	15 86	3054	16
74	-37 29	-13 36	19 34	16 17	4002	14
75	-35 08	-20 31	24 54	15 58	1434	13
76	-31 00	-25 27	24 66	16 1*	1847	11
77	-21 70	-28 20	21 72	17 62	0505	10
78	-15 80	-30 20	20 05	18 83	- 1834	10
79	-10 10	-30 40	18 41	19 82	- 2660	10
80	-4 36	-29 27	16 41	21 01	- 2463	11
81	1 36	-26 73	15 22	22 98	- 1987	11
82	7 00	23 09	14 61	24 44	- 1025	11
83	11 82	-18 64	14 38	25 76	- 0104	11
84	16 27	-13 64	14 33	27 28	0102	11
85	18 22	12 00	15 33	27 62	- 1787	9
86	19 33	-2 33	19 60	15 63	9427	3

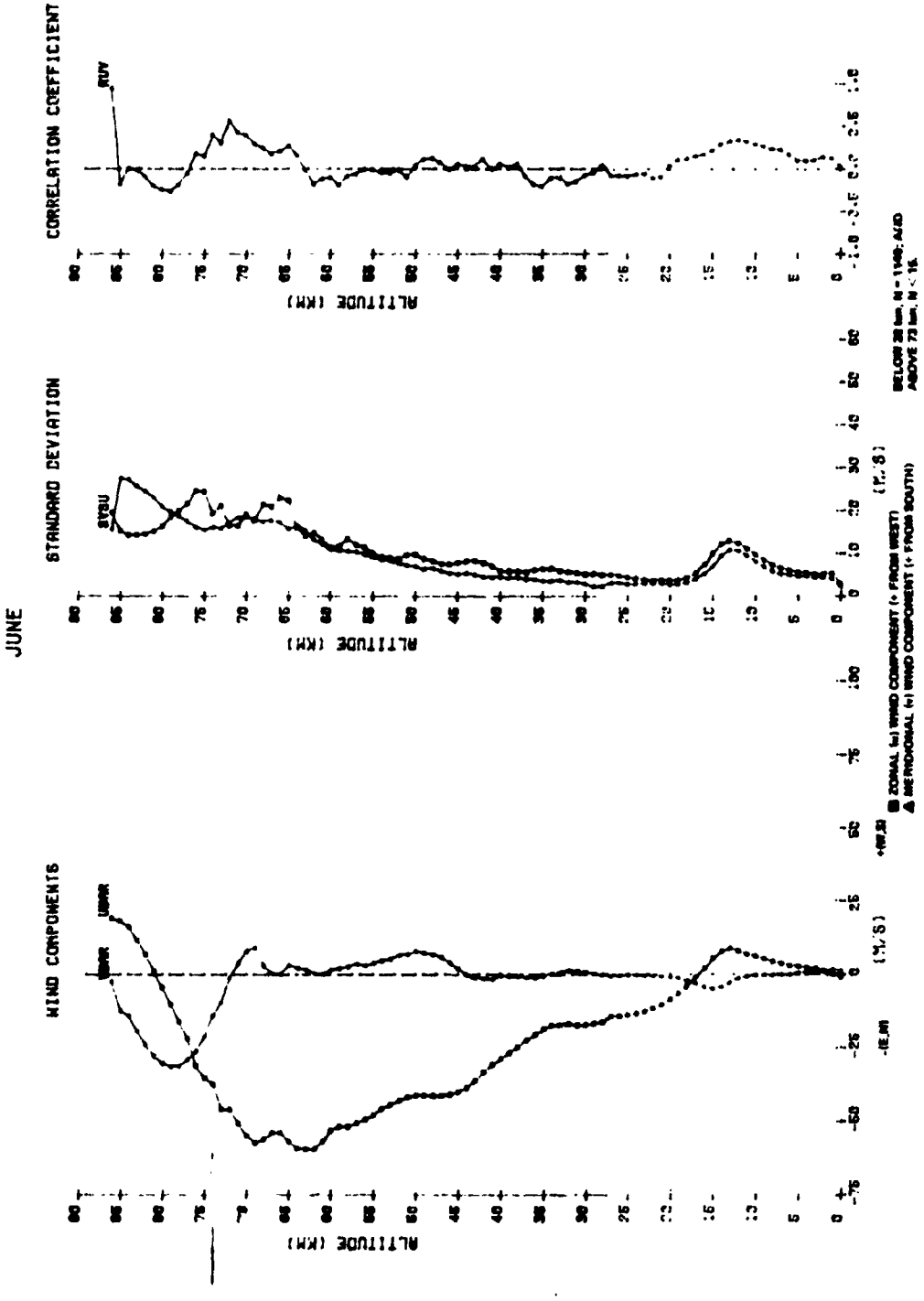

Figure 1.6. KSC bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 1.7. KSC BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

July

Alt (km)	ū	v̄	S(u)	S(v)	R(uv)	N
0	- 54	1 53	2 29	1 96	- 1370	1178
1	63	2 74	4 34	3 35	- 0144	1178
2	95	1 94	4 43	3 54	0654	1178
3	1 12	1 63	4 61	3 54	0995	1178
4	1 11	1 42	4 81	3 79	0843	1178
5	88	1 08	4 92	3 95	0510	1178
6	52	77	4 95	4 17	0431	1178
7	02	39	5 02	4 35	0935	1178
8	- 34	- 13	5 50	4 74	1759	1178
9	- 82	- 71	6 38	5 46	2705	1178
10	-1 19	-1 31	7 35	6 28	3698	1178
11	-1 70	-2 01	8 66	7 05	3235	1178
12	-2 30	-2 95	9 77	7 64	3190	1178
13	-3 01	-4 08	10 36	7 92	2831	1178
14	-3 55	-4 57	9 09	7 21	2509	1178
15	-4 26	-3 86	6 75	5 63	2748	1178
16	-4 86	-2 63	4 93	4 16	3044	1178
17	-6 00	-1 76	3 73	3 35	2364	1178
18	-8 10	-1 21	3 16	2 97	0879	1178
19	-10 44	- 99	3 05	2 71	1215	1178
20	-12 88	- 89	3 56	2 59	0010	1178
21	-14 97	- 54	3 50	2 90	- 2085	1178
22	-16 50	- 24	3 32	3 35	- 1356	1178
23	-17 60	- 08	3 38	3 24	- 0129	1178
24	-18 62	- 14	3 56	2 98	- 0581	1178
25	-19 34	- 44	3 91	2 94	- 0436	1178
26	-20 00	- 49	4 41	3 21	- 1377	1178
27	-20 41	- 61	4 64	3 54	- 1129	1178
28	-22 91	-1 11	3 21	2 62	1234	97
29	-23 34	- 83	3 35	2 80	0700	95
30	-24 78	- 07	3 75	3 06	2547	96
31	-25 64	1 09	4 46	3 13	0744	99
32	-26 25	1 56	4 63	3 56	- 0625	99
33	-26 40	1 13	5 10	3 71	- 0094	100
34	-27 03	61	5 16	3 34	- 0764	99
35	-28 10	48	4 86	3 77	- 1564	99
36	-29 21	19	4 61	3 74	- 0919	101
37	-30 91	24	5 24	4 29	- 0818	100
38	-32 28	35	5 46	4 78	0628	102
39	-34 15	14	5 24	4 78	- 0275	104
40	-35 96	04	5 23	4 90	- 0682	103
41	-37 69	- 02	5 02	5 08	- 0481	104
42	-39 93	-1 75	6 07	5 81	- 1918	106
43	-43 22	-1 40	6 20	6 16	- 1917	104
44	-46 58	- 18	5 80	6 99	- 0695	106
45	-48 60	1 66	6 34	7 60	1183	107
46	-49 14	3 22	7 69	7 65	2902	106
47	-50 39	3 88	7 85	6 69	2375	106
48	-51 40	4 10	8 54	6 59	2990	105
49	-51 35	4 54	8 57	6 30	0453	105
50	-52 11	4 93	8 52	7 40	- 0417	104
51	-52 91	4 97	8 58	7 71	- 0531	103
52	-54 59	5 62	8 19	7 92	- 0735	101
53	-54 51	5 67	9 09	9 44	- 1176	100
54	-54 17	6 33	9 78	10 84	0299	101
55	-53 70	6 03	10 47	11 50	2275	94
56	-51 89	5 62	11 76	11 45	2552	93
57	-51 29	4 13	12 65	11 21	2054	87
58	-49 30	3 92	14 23	12 04	1667	79
59	-47 97	3 76	15 15	12 32	0217	71
60	-46 13	4 98	16 16	13 47	0904	62
61	-45 33	4 16	20 90	16 18	2517	43
62	-42 28	5 19	24 50	17 57	3672	36
63	-37 80	4 30	29 76	17 32	3026	30
64	-35 70	5 09	32 20	18 25	2689	23
65	-35 62	6 04	31 20	18 07	2073	24
66	-35 35	6 57	30 59	20 24	2956	23
67	-38 45	13 15	33 24	21 67	0476	20
68	-32 53	14 26	27 37	21 18	- 0163	19
69	-28 16	6 16	26 24	22 93	- 0761	19
70	-20 50	-1 28	23 73	20 55	- 1924	18
71	-22 65	-5 71	21 02	18 05	- 2569	17
72	-21 44	-12 37	21 69	21 78	- 3460	16
73	-22 20	-20 33	23 45	24 42	- 4228	15
74	-29 58	-18 17	17 93	25 34	- 2819	12
75	-25 73	-22 73	20 10	29 03	- 3982	11
76	-22 60	-24 40	21 90	29 47	- 4009	10
77	-20 00	-24 00	23 75	36 51	- 4689	9
78	-12 30	-20 70	27 19	29 59	- 3069	10
79	-12 10	-23 90	24 32	27 73	- 6421	10
80	-8 20	-24 40	24 75	27 89	- 7128	10
81	-5 40	-24 90	24 34	28 76	- 7349	10
82	-1 60	-24 40	22 39	28 79	- 7536	10
83	89	-21 22	23 13	29 65	- 7295	9
84	4 44	-18 67	20 62	29 10	- 6736	9
85	8 11	-15 67	17 69	28 62	- 5784	9
86	11 17	-17 67	13 29	27 32	0452	6
87	13 25	-23 25	14 10	19 49	0866	4
88	12 50	-7 75	10 92	20 35	- 5731	4
89	11 25	1 00	11 01	22 05	- 6428	4
90	8 67	17 33	14 61	25 19	- 5021	3

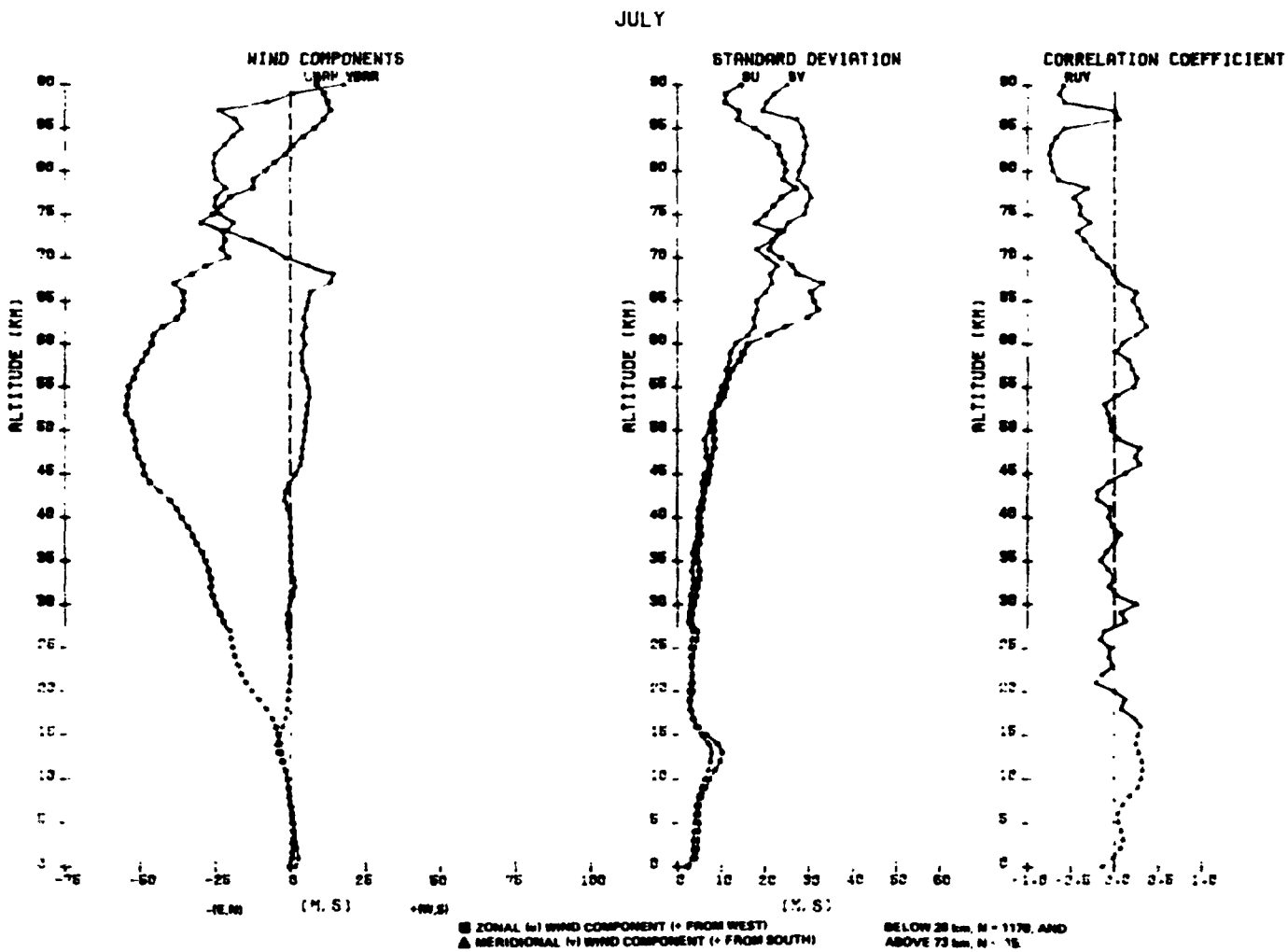

Figure 1.7. KSC bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 1.8. KSC BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

August

Alt (km)	ū	v̄	S(u)	S(v)	R(uv)	N
0	- 62	87	2 18	2 08	- 0157	1178
1	- 14	2 19	4 32	3 65	0074	1178
2	22	1 66	4 40	3 81	1728	1178
3	49	1 48	4 64	3 95	1845	1178
4	70	1 46	4 76	4 04	2099	1178
5	72	1 24	4 93	4 20	2051	1178
6	39	87	5 11	4 41	2475	1178
7	03	55	5 21	4 71	2693	1178
8	- 32	- 01	5 43	5 01	2642	1178
9	- 57	- 47	5 86	5 35	2971	1178
10	- 65	- 98	6 67	6 59	3356	1178
11	- 81	-1 37	7 72	7 49	3333	1178
12	-1 05	-2 03	8 69	8 39	3023	1178
13	-1 33	-2 96	8 79	8 56	4993	1178
14	-1 91	-3 32	7 85	7 36	3286	1178
15	-2 65	-2 56	6 19	5 29	3149	1178
16	-3 81	-1 69	4 93	3 89	2927	1178
17	-5 68	-1 12	3 61	3 23	1787	1178
18	-7 96	- 80	3 18	2 92	0453	1178
19	-10 42	- 69	3 23	2 62	0932	1178
20	-12 97	- 56	3 48	2 48	0411	1178
21	-14 95	- 35	3 46	2 71	- 0920	1178
22	-16 45	- 21	3 33	2 91	- 1258	1178
23	-17 51	- 13	3 49	3 01	0276	1178
24	-18 51	- 11	3 64	2 86	0180	1178
25	-19 36	- 26	3 80	2 93	- 0442	1178
26	-19 83	- 56	4 08	3 03	- 0895	1178
27	-20 47	- 84	4 36	3 28	- 0977	1178
28	-23 27	- 99	3 28	2 67	0229	86
29	-24 11	- 11	4 13	3 08	0676	87
30	-24 92	75	4 77	3 01	0820	88
31	-25 43	1 57	4 96	3 00	- 0931	89
32	-25 25	1 84	4 86	3 18	- 3662	89
33	-25 19	1 31	4 48	3 72	- 2095	89
34	-25 51	85	4 91	3 63	- 0294	89
35	-25 97	25	5 44	3 84	- 1768	87
36	-26 75	33	5 53	4 38	- 1506	88
37	-27 51	22	5 66	4 45	- 1525	89
38	-28 08	29	5 96	4 84	- 1208	89
39	-28 99	57	7 04	5 07	- 0799	91
40	30 23	11	7 38	5 40	- 0359	91
41	-31 20	- 19	7 95	5 44	- 1904	93
42	-33 78	- 91	8 38	5 60	- 2759	92
43	-35 60	- 54	8 32	5 55	- 1927	93
44	38 54	- 07	8 23	6 18	- 1506	94
45	-40 20	83	8 38	7 56	- 1815	92
46	-40 63	2 64	9 45	7 98	- 1715	92
47	-40 65	3 53	11 00	8 29	- 1317	94
48	-40 83	5 47	11 90	9 03	- 0391	90
49	-39 53	6 79	13 07	8 18	0364	92
50	-38 88	6 96	14 62	8 43	- 0652	91
51	-37 51	7 38	15 43	9 75	- 2009	91
52	-35 18	6 62	15 00	10 30	- 1644	88
53	-32 33	4 61	14 88	10 89	- 1512	88
54	-30 90	3 71	15 82	10 38	- 0330	87
55	-28 50	3 17	16 16	11 13	0591	88
56	-26 96	2 05	18 40	12 09	0756	85
57	-27 64	3 17	20 16	11 81	0143	76
58	24 72	4 96	20 56	13 79	- 1422	75
59	-21 62	6 66	18 57	14 80	- 2130	68
60	-17 04	4 59	17 61	14 00	- 0931	56
61	-11 87	2 02	18 42	13 08	- 1168	52
62	- 7 56	49	17 75	14 66	- 0515	43
63	- 8 24	-1 92	20 82	15 99	0194	37
64	- 9 29	-2 54	20 10	15 24	0196	35
65	- 8 56	-1 62	17 64	16 34	- 1298	34
66	- 8 42	-3 39	16 14	15 35	- 1508	33
67	- 7 89	-3 33	17 05	16 59	- 2865	27
68	-12 26	-3 78	15 83	15 64	- 3119	23
69	-11 13	- 96	17 35	18 20	- 2070	23
70	- 9 45	-5 30	21 17	17 64	- 2713	20
71	-10 44	-2 49	14 87	16 31	- 1538	16
72	-11 36	-4 86	17 31	14 23	- 1405	14
73	-13 58	-12 83	20 28	12 69	- 3369	12
74	-14 55	-13 18	19 61	11 65	- 2130	11
75	- 8 50	-14 80	15 36	13 59	3200	10
76	11 11	-17 33	15 74	13 28	3979	9
77	-11 78	-16 89	16 64	14 67	5174	9
78	-12 22	-14 89	16 42	15 26	5176	9
79	-12 56	-12 33	16 65	16 54	4338	9
80	-12 69	- 8 11	16 19	17 91	3695	9
81	-12 44	-2 22	17 11	18 38	3633	9
82	-11 33	4 67	18 23	18 95	4495	9
83	- 9 67	12 56	20 24	20 14	6191	9
84	- 7 11	20 11	22 68	23 90	7160	8
85	- 8 13	18 75	21 49	19 54	4845	8
86	- 9 75	22 79	26 29	26 94	7954	4

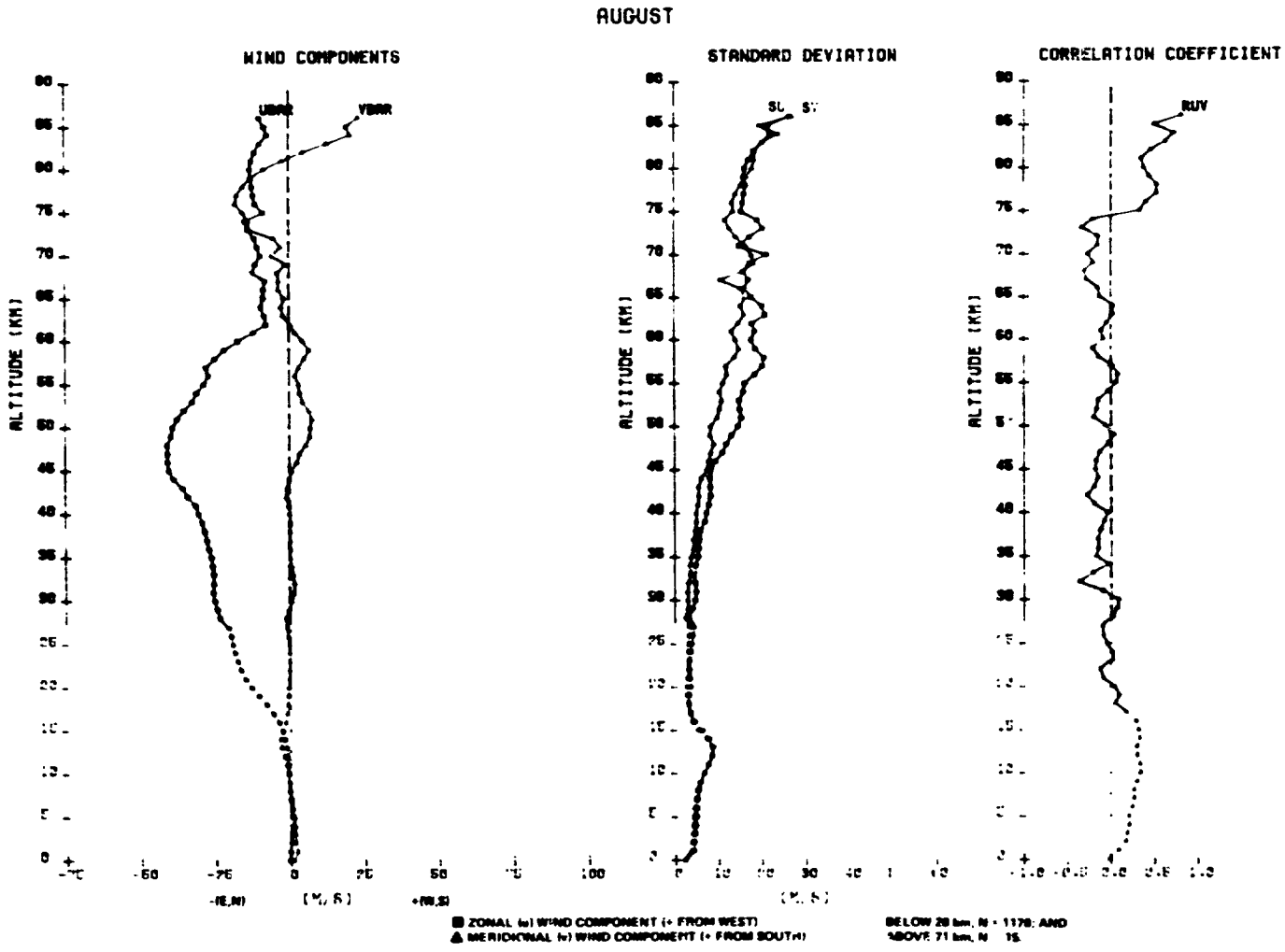

Figure 1.8. KSC bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 1.3. KSC BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

September

Alt (km)	$\bar{u}$	$\bar{v}$	S(u)	S(v)	R(uv)	N
0	-1 58	- 12	2 79	2 63	2230	1140
1	-2 25	41	5 49	4 68	2439	1140
2	-1 13	33	5 84	4 58	2683	1140
3	- 25	36	5 86	4 52	2933	1140
4	38	40	5 86	4 52	2664	1140
5	74	17	6 07	4 79	2653	1140
6	98	- 04	6 35	5 18	2434	1140
7	1 37	- 13	6 84	5 65	2771	1140
8	1 93	- 34	7 49	6 20	3365	1140
9	2 72	- 48	8 20	6 98	3521	1140
10	3 45	- 88	9 16	8 11	3507	1140
11	4 16	-1 37	10 21	9 25	3392	1140
12	4 98	-2 06	10 87	10 20	2982	1140
13	5 07	-2 82	11 09	10 60	2785	1140
14	4	-3 35	10 24	9 51	2484	1140
15	2	-3 07	8 54	7 19	2114	1140
16	- 09	-2 44	6 57	5 15	2507	1140
17	-2 06	-1 42	5 30	3 76	1719	1140
18	-3 98	- 75	4 33	3 05	1702	1140
19	-6 03	- 64	3 90	2 72	1830	1140
20	-8 10	- 57	3 96	2 51	1300	1140
21	-9 87	- 31	3 74	2 38	0356	1140
22	-11 17	- 22	3 77	2 64	- 0353	1140
23	-12 01	- 14	3 90	2 69	- 0120	1140
24	-12 58	- 32	4 06	2 76	- 0263	1140
25	-13 21	- 48	4 27	2 99	- 0542	1140
26	-13 56	- 65	4 63	2 99	- 0175	1140
27	-13 81	- 72	5 07	3 34	- 0739	1140
28	-15 99	- 86	5 06	2 53	0177	79
29	-16 47	- 51	5 34	2 57	- 0613	80
30	-16 91	25	5 49	3 29	- 1083	79
31	-16 23	1 35	5 77	3 76	0391	81
32	-14 59	1 72	6 18	3 72	1419	80
33	-13 13	1 54	6 74	3 21	1814	79
34	-11 97	1 01	7 58	3 56	- 0483	79
35	-11 07	1 06	7 95	3 44	- 1552	80
36	-10 74	- 12	7 92	4 11	- 2948	81
37	-11 38	- 94	7 87	4 90	- 1510	81
38	-11 43	-1 01	8 49	4 48	- 0204	83
39	-10 83	- 13	9 94	4 77	- 0673	84
40	-10 52	- 70	10 25	5 56	- 1025	83
41	-10 81	1 53	10 34	5 68	0317	81
42	-11 10	12	9 97	6 44	0200	81
43	-11 15	36	10 94	5 32	0222	87
44	-10 99	1 38	11 18	6 25	- 0157	89
45	-10 30	2 55	11 65	6 07	0483	88
46	-9 51	2 49	12 59	6 60	- 2243	88
47	-8 92	2 31	13 09	8 49	- 2134	87
48	-7 51	2 17	13 73	7 45	- 1108	87
49	-6 50	2 27	14 25	7 16	- 0616	86
50	-4 98	3 20	15 32	6 85	- 0697	89
51	-3 19	4 07	15 12	7 56	- 1356	89
52	-1 22	4 40	14 32	8 19	- 0883	88
53	1 94	3 86	12 97	7 38	- 1086	85
54	3 00	4 72	12 61	8 22	- 3180	86
55	4 19	4 43	11 52	8 15	- 3922	86
56	3 60	4 29	11 94	8 98	- 2719	85
57	6 16	4 57	10 81	9 35	- 1500	79
58	5 86	3 72	10 90	9 53	0400	74
59	5 61	2 64	11 94	9 30	1611	66
60	8 03	2 54	11 70	10 03	1408	59
61	8 34	2 02	12 29	10 52	0899	41
62	9 79	2 32	10 99	11 30	- 1998	28
63	9 46	2 83	11 96	11 16	- 3067	24
64	8 89	- 67	13 33	10 25	0877	18
65	9 13	- 33	15 56	12 37	4115	15
66	11 18	2 35	15 22	10 31	3122	17
67	8 75	3 31	11 35	12 84	1137	16
68	7 73	5 09	8 06	16 38	2302	11
69	9 38	7 15	15 57	17 28	- 3142	13
70	11 36	4 93	11 90	16 45	- 1353	14
71	11 43	50	13 82	13 68	- 0412	14
72	11 67	-5 87	17 50	9 73	0253	15
73	4 42	-9 75	16 38	9 61	0422	12
74	5 18	-15 55	17 04	14 96	- 2538	11
75	-2 50	-9 67	19 58	13 11	1143	6
76	-3 25	-11 12	16 69	15 06	6459	8
77	-8 29	-7 86	16 35	10 56	3882	7
78	-9 14	-7 86	14 18	8 74	5892	7
79	-11 17	-5 00	13 93	8 77	6816	6
80	-12 83	33	11 88	9 67	6191	6
81	-14 17	6 33	10 12	10 39	5743	6
82	-14 17	12 33	10 82	11 83	5056	6
83	-14 33	17 33	11 54	12 34	4467	6
84	-12 83	22 67	14 06	13 09	4960	6
85	-8 00	27 60	17 26	14 92	4729	5
86	6 33	34 33	19 70	14 70	1177	3

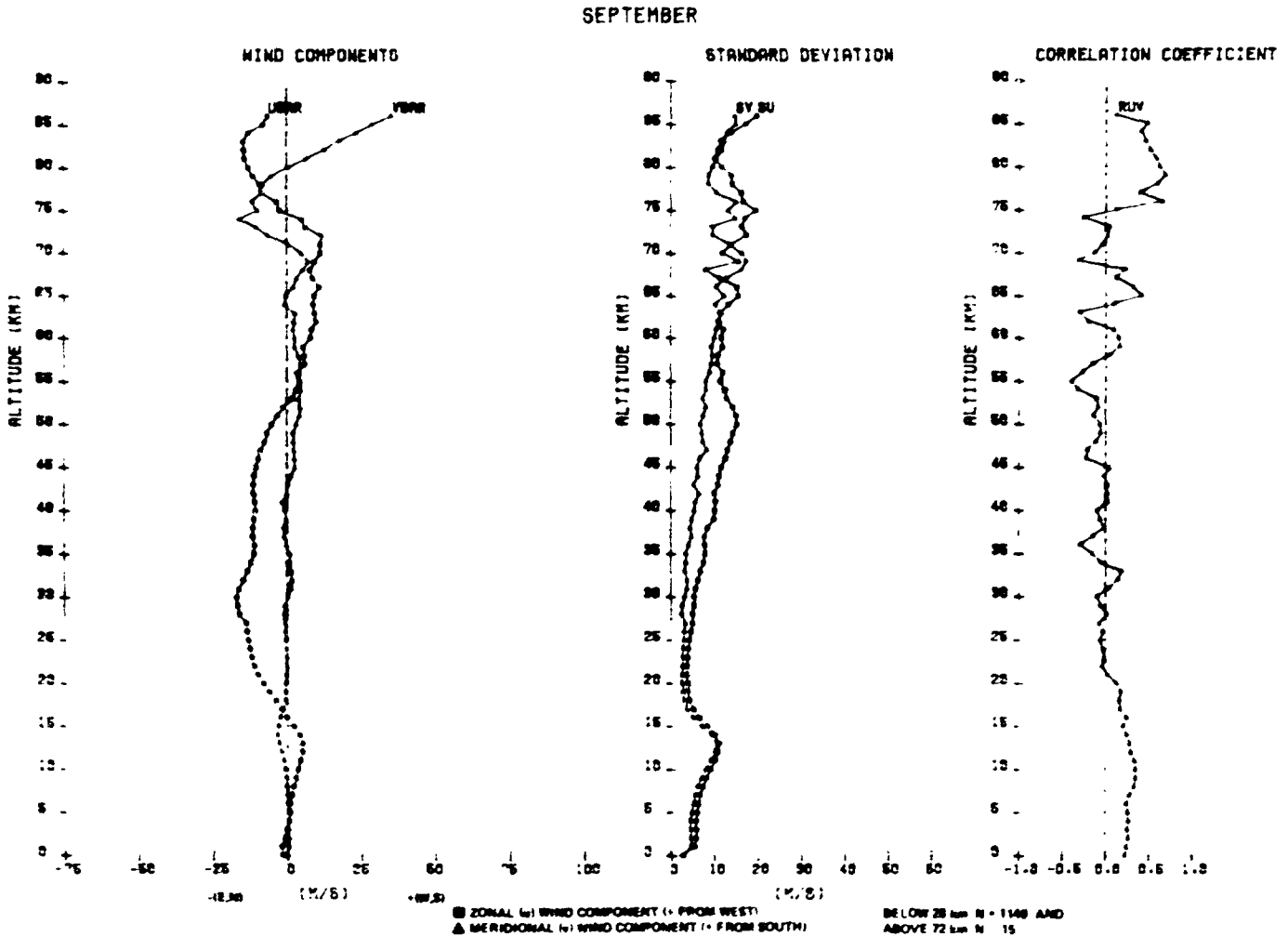

Figure 1.9. KSC bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 1.10. KSC BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

October

Alt (km)	$\bar{u}$	$\bar{v}$	S(u)	S(v)	R(uv)	N
0	-1 29	-1 13	3 26	2 89	0822	1178
1	-2 28	-1 16	5 97	5 01	2270	1178
2	- 03	32	6 26	4 86	2510	1178
3	1 94	05	6 39	4 94	2184	1178
4	3 54	01	6 58	5 24	2175	1178
5	5 23	- 17	6 99	5 97	2592	1178
6	7 05	- 25	7 63	6 70	2688	1178
7	9 06	31	8 60	7 65	2488	1178
8	11 28	- 26	9 68	8 86	239*	1178
9	13 48	- 22	11 06	10 26	2244	1178
10	15 70	- 12	12 30	12 04	1984	1178
11	18 05	- 30	13 36	13 49	1867	1178
12	19 70	- 49	13 61	14 31	2132	1178
13	19 99	-1 02	13 28	13 50	2376	1178
14	18 56	-1 43	12 23	11 37	2455	1178
15	15 45	-1 42	10 35	8 95	2397	1178
16	11 07	-1 20	8 41	6 71	2537	1178
17	6 56	- 82	6 96	4 81	2603	1178
18	2 72	- 60	5 77	3 61	2705	1178
19	03	- 44	4 99	3 13	1822	1178
20	-1 71	- 24	4 62	2 92	1456	1178
21	2 68	- 27	4 39	2 74	1684	1178
22	-3 35	- 37	4 41	2 79	0757	1178
23	-3 81	- 38	4 61	2 75	0674	1178
24	3 95	- 38	4 82	2 83	0318	1178
25	-3 66	- 40	5 17	3 01	0758	1178
26	-3 09	- 50	5 73	3 11	1258	1178
27	-2 39	- 60	6 04	3 30	0982	1178
28	-4 10	28	5 61	2 72	1014	87
29	-3 04	37	5 95	3 15	3187	89
30	-2 51	52	6 44	3 09	1378	87
31	-1 24	1 34	6 96	3 70	0659	90
32	43	2 09	7 20	3 98	0896	89
33	2 83	2 46	7 43	4 14	1853	89
34	5 39	1 62	8 28	4 50	2304	92
35	8 02	07	9 58	5 13	2923	94
36	9 35	-1 01	11 28	4 81	1533	94
37	10 69	-1 04	11 94	5 50	- 0680	93
38	12 63	- 46	12 18	5 93	- 1025	97
39	13 91	- 20	12 54	6 08	0226	98
40	15 56	- 12	13 48	6 01	0963	98
41	16 69	58	14 07	6 10	2553	97
42	18 92	1 24	14 88	5 83	2789	99
43	20 10	1 74	15 63	5 97	2219	100
44	22 27	2 81	16 61	5 96	3314	99
45	24 38	3 87	17 15	6 46	3078	102
46	27 11	4 27	18 01	7 02	3157	103
47	28 83	4 58	19 98	7 65	3039	103
48	30 39	5 12	19 96	8 03	3128	99
49	31 58	5 27	20 72	7 99	3833	102
50	33 29	5 69	20 87	8 24	3976	102
51	34 69	6 10	21 08	8 50	4257	98
52	36 86	6 65	22 01	8 68	3929	100
53	37 79	7 40	21 29	8 45	2732	100
54	39 13	7 37	21 50	8 55	3166	97
55	40 27	7 07	21 65	7 96	3472	97
56	40 23	6 14	21 84	8 63	3801	92
57	38 72	4 33	20 44	9 43	3486	83
58	38 96	2 98	20 54	10 06	3661	83
59	38 08	3 62	21 25	10 32	3300	77
60	37 00	3 87	19 62	10 74	3781	62
61	33 68	3 21	19 26	11 11	2993	47
62	32 00	3 02	18 70	9 83	0724	42
63	31 67	1 75	18 03	10 29	0491	36
64	32 31	2 56	18 48	10 65	- 0090	36
65	30 19	4 59	18 94	10 45	- 0182	32
66	28 07	7 21	18 16	11 46	0770	29
67	27 19	9 58	18 00	15 26	0196	26
68	25 19	12 92	18 25	14 36	0638	26
69	23 92	15 12	19 26	14 94	- 1388	26
70	22 19	17 38	18 70	14 38	- 2402	26
71	24 16	11 12	19 33	15 71	- 5115	25
72	19 00	6 74	15 33	16 20	- 5720	23
73	14 21	6 08	13 89	16 21	- 0515	24
74	8 05	4 38	14 86	15 10	0082	21
75	3 61	5 00	14 04	13 74	0812	18
76	-3 42	3 84	14 38	17 01	1975	19
77	-4 22	4 83	13 07	18 72	1898	18
78	-4 89	6 28	13 90	19 64	3566	18
79	-6 32	7 37	17 32	18 97	5354	19
80	-5 83	8 67	18 18	17 41	5908	18
81	- 82	12 00	17 63	16 06	5690	17
82	3 11	14 41	19 99	15 92	3703	17
83	8 44	16 37	23 15	17 30	0355	16
84	13 94	18 56	25 49	20 12	- 2903	16
85	23 37	14 37	26 35	18 06	- 4864	8
86	30 17	13 33	29 54	24 13	- 6913	6
87	30 50	13 50	34 49	35 72	- 9067	4
88	35 50	15 00	33 57	42 47	- 8660	4
89	40 00	16 00	32 53	47 09	- 8272	4
90	43 25	13 75	31 67	48 00	- 7606	4

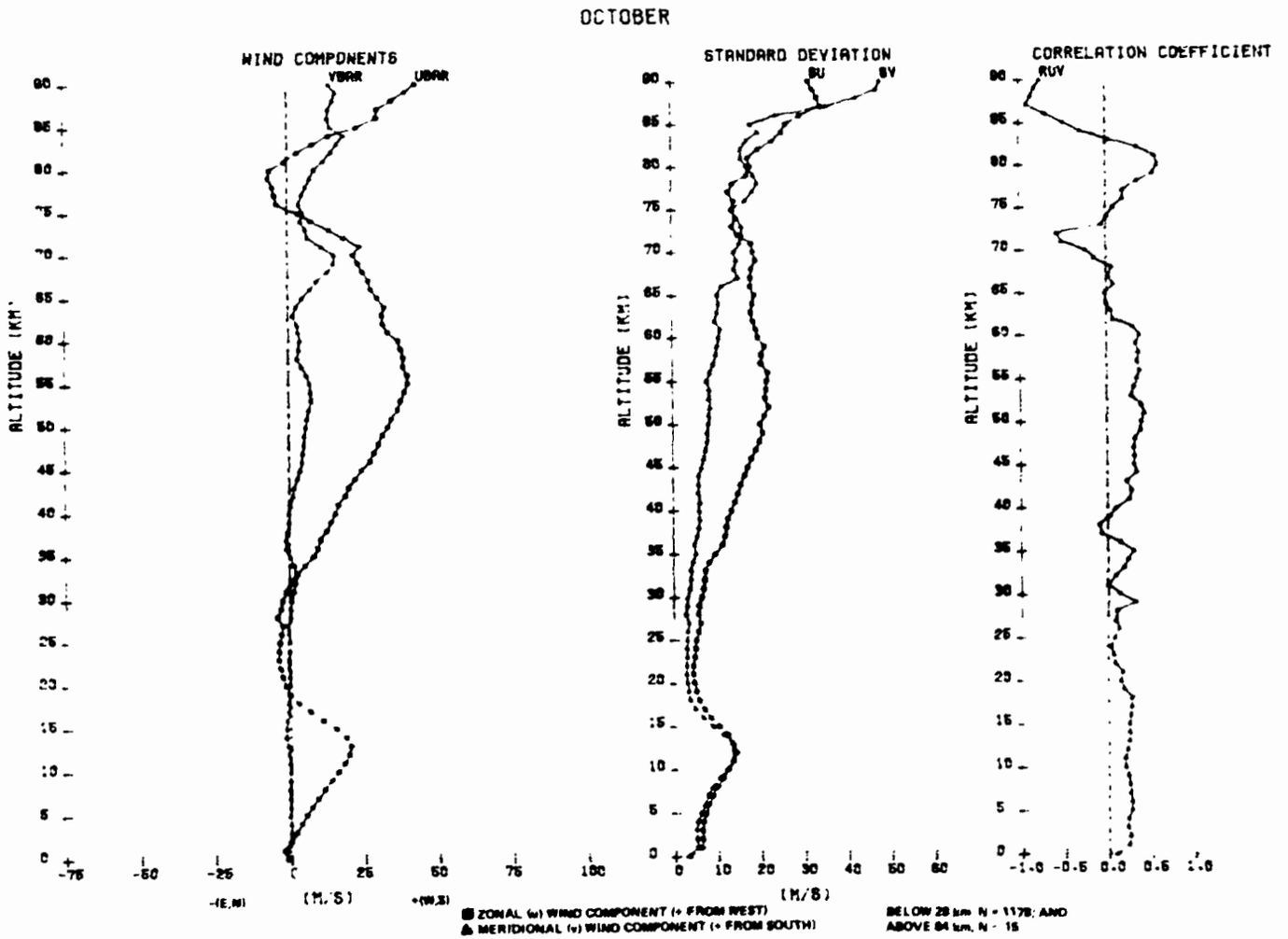

Figure 1.10. KSC bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 1.11. KSC BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

November

Alt (km)	$\bar{u}$	$\bar{v}$	S(u)	S(v)	R(uv)	N
0	- 14	- 88	3 03	2 93	- 1471	1140
1	08	- 33	6 76	5 36	1399	1140
2	2 77	06	7 23	5 31	1699	1140
3	5 41	- 08	7 59	5 60	1847	1140
4	7 72	- 14	7 95	6 26	2039	1140
5	10 28	- 12	8 75	6 92	2396	1140
6	12 95	- 14	9 71	7 91	2871	1140
7	15 62	- 13	10 46	9 03	3056	1140
8	18 52	- 24	11 44	10 28	3119	1140
9	21 39	- 04	2 47	11 50	3297	1140
10	24 24	- 01	13 59	12 91	3441	1140
11	27 33	- 04	14 98	14 20	3358	1140
12	29 73	- 18	14 25	15 08	3503	1140
13	32 39	- 05	13 42	13 88	3287	1140
14	48 56	- 20	12 17	11 60	7224	1141
15	24 64	- 09	10 29	9 55	2994	1140
16	20 03	- 25	8 76	8 03	2741	1140
17	14 96	- 37	7 64	6 75	1855	1140
18	9 88	- 39	6 63	5 13	1501	1140
9	6 17	- 08	5 68	4 11	1486	1140
20	3 99	00	5 18	3 40	1598	1140
21	3 26	05	5 33	3 11	2226	1140
22	3 11	13	5 74	3 30	1953	1140
23	3 68	27	6 21	3 33	1590	1140
24	4 67	27	6 78	3 45	1698	1140
25	6 13	19	7 63	3 80	2063	1140
26	7 63	18	8 21	3 90	1830	1140
27	9 17	38	8 85	4 04	1110	1140
28	8 17	1 90	9 [illegible]	3 84	- 0893	92
29	10 47	2 34	9 85	3 92	- 0516	95
30	12 32	2 83	10 84	4 59	- 1059	94
31	15 51	3 61	12 31	5 07	- 1022	97
32	18 38	3 74	12 72	5 08	0288	97
33	21 58	4 12	14 05	5 37	- 0452	99
34	25 71	3 49	14 46	5 17	- 1918	99
35	28 91	2 66	14 50	5 25	- 184	98
36	31 62	1 65	15 04	6 36	- 1086	100
37	34 20	2 19	14 77	7 64	- 1953	96
38	36 71	2 28	14 35	8 22	- 1251	101
39	39 25	1 91	14 58	8 45	- 1008	101
40	41 24	3 04	14 16	8 33	0610	103
41	43 07	3 69	14 53	8 75	0929	104
42	45 07	5 37	14 67	8 91	1858	104
43	47 42	7 33	15 17	9 52	3491	106
44	50 25	9 58	15 35	9 33	3632	106
45	53 86	10 04	15 28	8 98	3546	108
46	56 86	11 48	15 07	9 56	2219	107
47	59 56	12 34	14 92	10 92	2716	107
48	61 39	14 03	15 29	11 18	2495	105
49	63 96	15 20	15 09	11 58	3053	103
50	65 83	13 58	15 22	11 43	3628	105
51	67 09	12 52	15 53	11 77	3054	103
52	68 74	12 01	15 69	11 20	2377	99
53	69 87	12 19	16 66	12 05	2066	100
54	69 90	11 96	16 67	12 52	1751	100
55	69 77	11 69	16 92	11 88	1912	96
56	69 26	10 60	16 78	11 28	2256	91
57	68 52	9 67	17 26	12 43	2788	86
58	67 69	10 05	18 09	14 16	1936	83
59	67 28	10 68	17 49	15 00	1636	79
60	66 13	8 37	18 26	13 78	1593	70
61	65 34	5 26	19 01	13 66	1670	53
62	65 07	7 93	20 58	14 56	1818	44
63	60 76	8 55	22 43	14 27	- 0032	38
64	59 59	10 26	23 66	14 49	- 0940	34
65	58 29	9 49	23 20	14 44	- 0751	35
66	62 27	8 93	16 36	13 78	0629	39
67	57 21	7 86	17 11	15 73	0523	28
68	56 38	4 62	21 93	16 16	2938	21
69	48 91	5 48	20 09	17 47	- 0631	23
70	42 91	6 22	19 63	18 69	- 2548	23
71	37 71	5 86	19 42	15 37	- 1257	21
72	28 81	8 33	17 61	14 33	- 1182	21
73	25 53	10 53	23 32	17 47	- 2426	19
74	25 67	13 95	24 41	20 97	- 2278	21
75	21 36	14 73	22 73	22 62	- 2564	22
76	16 00	13 19	22 91	21 38	- 3229	21
77	15 43	14 57	23 23	19 50	- 2778	21
78	15 62	15 43	23 41	17 95	- 2278	21
79	16 62	16 05	24 05	15 79	- 2368	21
80	18 33	16 52	24 82	15 00	- 2942	21
81	20 62	16 38	25 10	15 14	- 3351	21
82	23 19	15 81	25 33	17 69	- 3460	21
83	26 70	15 35	24 75	21 67	- 3599	20
84	29 28	14 44	23 74	26 45	- 3464	18
85	25 09	5 82	24 15	26 87	- 4972	11
86	20 75	1 12	25 43	26 43	- 2960	8
87	7 00	8 00	21 42	33 11	- 3575	5
88	3 60	6 80	28 12	40 35	- 4010	5
89	2 40	8 20	33 28	43 87	- 5915	5
90	- 50	20 75	40 28	46 78	- 7344	4

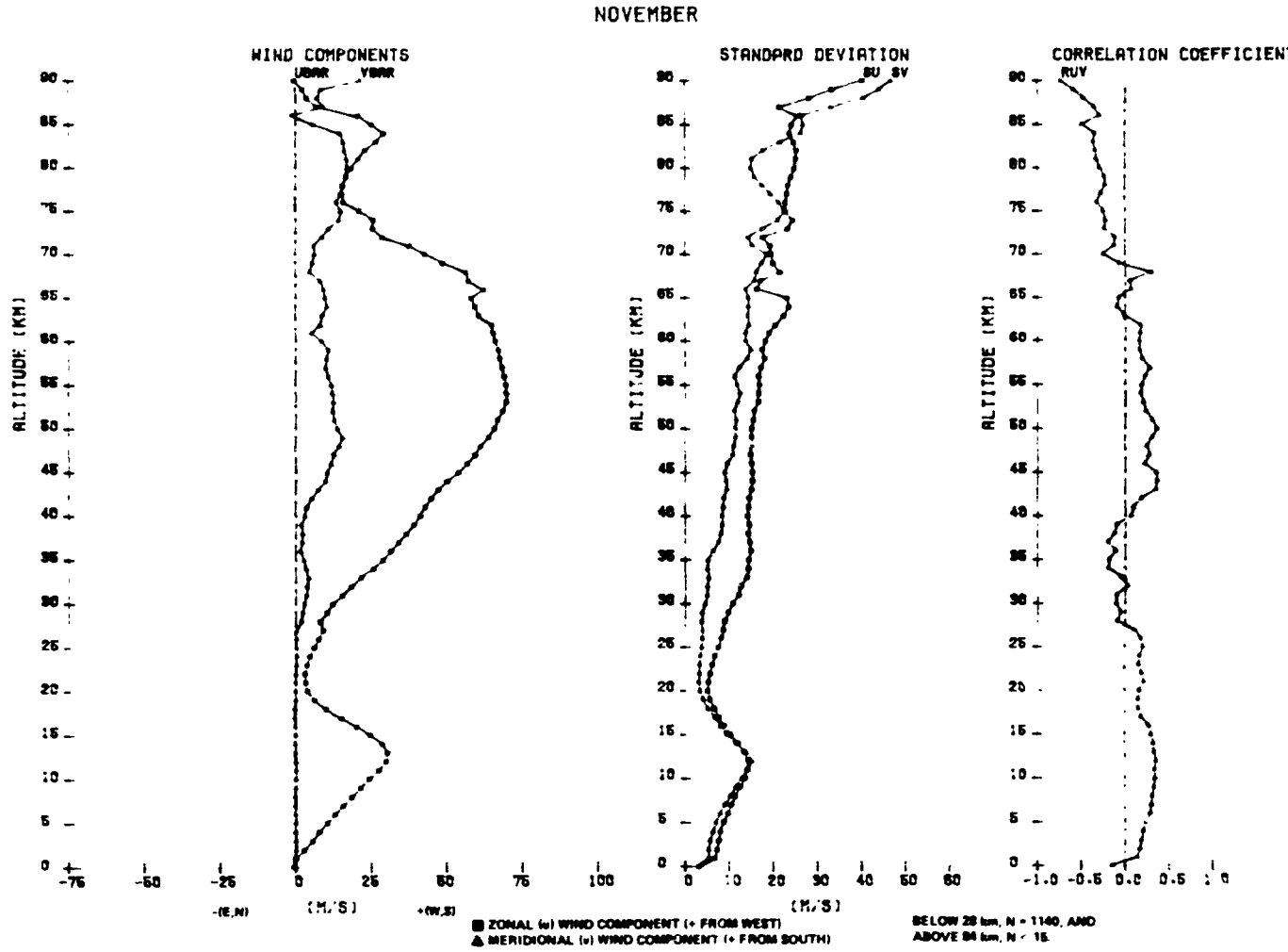

Figure 1.11. KSC bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 1.12. KSC BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

December

Alt (km)	$\bar{u}$	$\bar{v}$	S(u)	S(v)	R(uv)	N
0	39	- 65	2 94	3 03	- 2762	1178
1	1 33	67	6 87	5 97	- 0232	1178
2	4 61	90	7 32	5 78	- 0039	1178
3	7 85	80	7 70	6 31	0556	1178
4	11 11	1 13	8 28	7 10	1273	1178
5	14 02	1 59	8 97	8 11	1510	1178
6	17 00	1 64	9 65	8 96	1823	1178
7	20 00	1 88	10 66	9 87	2088	1178
8	23 02	2 22	11 89	10 69	2621	1178
9	26 10	2 50	13 35	11 75	2938	1178
10	29 10	2 54	14 66	13 10	2925	1178
11	31 73	2 37	15 29	14 18	2938	1178
12	34 24	2 47	15 40	14 67	2873	1178
13	35 15	2 62	14 39	13 62	3142	1178
14	33 73	2 37	13 04	11 39	3403	1178
15	30 24	2 08	11 37	9 77	3181	1178
16	25 71	1 91	9 65	8 73	2757	1178
17	20 71	1 49	8 57	7 76	2529	1178
18	15 20	98	7 68	6 24	2257	1178
19	10 19	64	7 05	4 88	2396	1178
20	7 39	35	6 62	3 98	1888	1178
21	6 43	29	6 49	3 69	2674	1178
22	6 53	08	6 41	3 34	2570	1178
23	7 46	07	6 98	3 48	2080	1178
24	9 31	31	7 74	3 94	2095	1178
25	11 33	46	8 42	3 84	2106	1178
26	12 99	63	9 25	4 07	1577	1178
27	14 39	98	9 98	4 31	1448	1178
28	15 11	3 06	9 16	4 97	4169	93
29	17 89	3 73	9 62	5 51	4297	95
30	20 52	4 85	10 19	5 99	4830	95
31	22 83	6 46	10 69	6 91	3479	101
32	25 64	7 49	11 03	6 83	2665	100
33	28 34	7 15	12 15	7 98	2622	102
34	30 80	7 28	12 76	7 47	2724	103
35	32 40	6 77	13 69	7 26	1467	103
36	33 17	5 89	14 50	6 93	- 0350	103
37	33 73	6 49	15 24	7 52	- 1462	106
38	34 18	6 87	15 92	8 93	- 2086	106
39	33 99	7 86	15 69	8 90	- 0709	107
40	34 52	8 59	15 92	9 98	- 0580	104
41	34 35	8 71	16 11	10 88	- 0216	109
42	34 11	8 79	17 50	11 40	0599	112
43	33 71	9 54	18 92	11 47	0441	112
44	33 68	9 19	20 70	11 06	0507	111
45	33 87	10 57	21 40	12 77	- 0498	112
46	33 32	11 04	21 89	11 69	- 1698	113
47	31 94	10 52	22 63	11 41	- 0739	108
48	31 97	10 62	24 08	12 32	- 0858	109
49	32 31	10 87	24 59	12 46	- 0438	103
50	32 90	12 10	24 07	12 23	0462	104
51	33 54	12 10	24 59	13 52	0587	100
52	32 36	12 87	25 63	13 51	- 0276	100
53	33 16	12 21	27 55	12 92	- 0314	100
54	34 50	11 16	27 87	12 96	- 1434	101
55	35 24	11 28	27 96	14 12	- 1104	101
56	36 66	11 48	27 02	15 19	- 0450	100
57	39 35	11 70	27 11	14 38	0155	93
58	41 29	11 77	27 08	15 09	0612	83
59	42 94	10 62	26 48	14 40	2165	71
60	43 60	12 54	27 51	16 55	1372	65
61	43 09	13 85	29 28	17 67	1579	55
62	44 89	12 47	28 85	16 03	1753	53
63	45 26	10 16	28 27	16 82	2558	50
64	48 42	8 46	30 03	16 10	2760	48
65	49 71	6 05	32 84	15 83	2942	42
66	49 46	2 41	34 60	18 13	2756	37
67	47 48	- 06	33 34	20 76	2910	31
68	50 04	2 07	31 48	20 79	3092	28
69	50 23	- 77	30 56	19 23	3993	30
70	57 00	-3 04	24 73	21 85	3259	28
71	58 31	-7 79	27 07	19 38	2649	29
72	56 38	-11 04	25 67	19 73	0480	26
73	50 04	-17 00	29 44	21 68	- 0174	23
74	47 82	-20 45	32 28	24 86	0005	22
75	38 95	-21 25	33 34	28 24	0777	20
76	29 62	-19 48	35 05	29 36	1339	21
77	23 85	-15 20	36 51	30 07	1856	20
78	20 05	-8 62	35 49	29 58	2537	21
79	15 00	-1 20	36 77	26 67	2716	20
80	12 70	5 00	35 72	24 22	4079	20
81	11 65	10 35	34 41	22 31	3812	20
82	11 75	15 00	32 63	21 29	2948	20
83	12 90	19 45	30 64	22 44	1861	20
84	18 17	21 17	24 75	23 91	1197	18
85	18 27	25 47	25 33	16 60	1208	15
86	13 00	24 00	16 01	10 60	- 1670	6
87	11 75	17 75	11 34	12 32	- 0720	4
88	18 67	12 67	8 34	18 08	4900	3

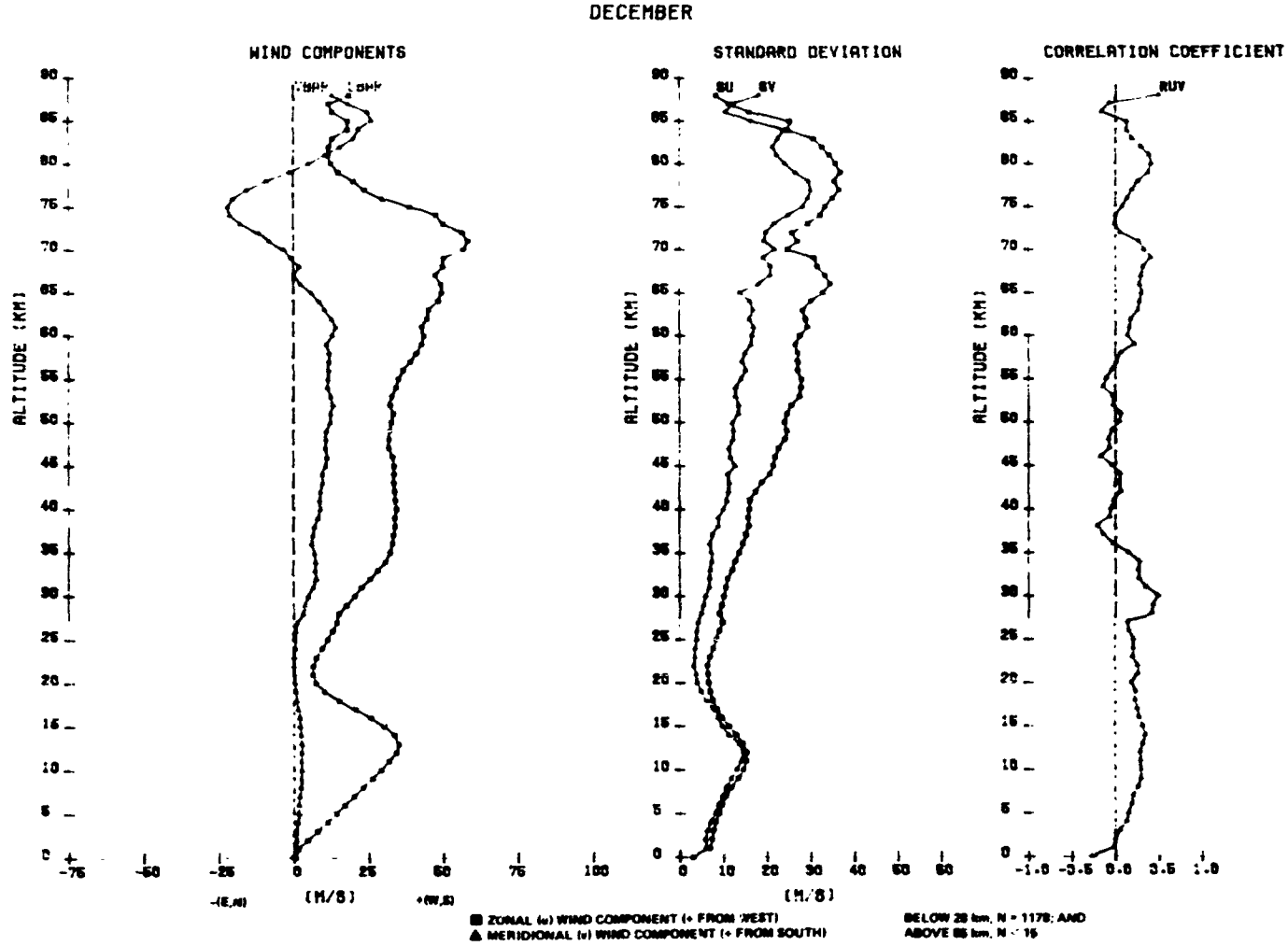

Figure 1.12. KSC bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 2.1. VAFB BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

January

Alt (km)	$\bar{u}$	$\bar{v}$	S(u)	S(v)	R(uv)	N
0	42	- 62	2 89	3 43	- 9137	620
1	1 08	-1 55	4 34	7 07	0402	620
2	3 57	-2 61	5 87	7 75	1187	620
3	6 38	-3 33	7 80	8 73	1907	620
4	8 78	-3 61	9 49	9 76	2065	620
5	11 10	-3 45	11 12	10 98	2550	620
6	12 92	-3 64	12 55	12 22	2757	620
7	14 83	-4 15	13 96	13 44	2816	620
8	16 68	-4 50	15 65	14 69	2816	620
9	18 76	-5 02	17 22	15 81	2709	620
10	21 08	-5 39	18 60	16 99	2601	620
11	23 73	-5 41	19 45	17 23	2412	620
12	25 09	-5 26	18 34	16 01	2201	620
13	24 33	-4 64	15 40	13 34	2651	620
14	22 60	-4 10	13 34	11 36	3028	620
15	19 77	-3 52	10 99	9 87	3158	620
16	16 77	-3 11	9 41	8 29	3310	620
17	13 49	-2 97	8 19	6 65	3274	620
18	9 91	-2 93	6 99	5 40	3286	620
19	6 80	-2 90	6 60	4 74	3646	620
20	3 81	-2 86	6 80	4 89	2914	620
21	1 79	-2 91	6 90	3 85	2322	620
22	08	-2 99	7 34	3 77	2616	620
23	-1 06	-3 02	8 10	3 85	3676	620
24	-1 45	-2 84	9 28	4 17	3578	620
25	-1 78	-2 63	10 49	4 38	3599	620
26	-1 63	-2 89	11 56	4 71	3777	624
27	-1 01	-3 12	12 90	5 11	4350	620
28	1 27	-1 25	14 17	5 33	5434	118
29	3 09	-1 06	15 57	5 88	4858	124
30	4 20	-1 25	16 83	6 51	4845	129
31	5 73	- 88	17 92	7 36	4517	129
32	7 66	- 95	19 73	7 68	4870	133
33	9 08	- 54	21 09	8 64	5336	132
34	11 70	- 24	22 50	9 66	5468	132
35	12 74	- 29	23 72	10 06	5622	133
36	14 23	- 45	24 89	10 42	5961	132
37	16 73	-1 18	25 94	10 64	5492	131
38	18 18	-1 12	26 80	11 09	5084	132
39	19 20	- 91	26 56	11 38	4615	133
40	20 96	-1 04	26 37	12 13	4139	131
41	22 63	- 85	26 71	12 89	3625	130
42	25 34	79	25 86	13 86	2959	131
43	28 78	1 99	26 12	15 77	3650	134
44	32 34	2 92	26 84	16 77	3818	131
45	37 06	5 92	27 35	18 29	3621	133
46	40 57	7 66	30 05	20 59	4323	134
47	43 68	8 70	31 23	20 83	4171	132
48	46 88	9 13	32 13	21 21	4617	129
49	48 25	10 93	31 96	20 82	4491	134
50	49 42	12 09	31 62	20 33	4589	130
51	51 17	12 92	30 22	19 76	4543	132
52	51 56	12 04	29 63	18 41	4268	130
53	52 76	11 90	28 95	18 49	4406	130
54	54 35	11 71	28 52	18 95	4059	128
55	55 33	11 28	28 24	18 70	3719	124
56	55 50	10 23	29 50	18 30	3266	124
57	57 74	10 50	28 60	18 69	2316	117
58	58 44	10 45	29 02	19 14	2032	104
59	59 51	8 91	30 40	19 02	3262	86
60	62 09	7 79	2' 96	21 96	4245	66
61	67 00	11 83	28 44	20 38	4015	48
62	70 51	14 74	27 84	18 90	3312	35
63	73 80	15 80	28 69	16 11	1870	30
64	78 80	13 77	28 70	16 19	1008	30
65	83 90	9 76	28 95	13 36	0939	29
66	90 59	5 30	25 44	13 12	1447	27
67	86 73	2 38	24 75	13 19	2212	26
68	89 69	00	24 32	12 87	2145	26
69	86 11	-4 11	25 30	15 69	2714	27
70	80 93	-5 21	25 97	18 06	1463	28
71	77 81	-5 44	26 65	19 51	0743	27
72	74 67	-6 00	25 36	20 30	0199	27
73	71 73	-7 00	24 41	21 83	- 0171	26
74	67 83	-9 35	23 06	24 97	- 1561	23
75	62 95	8 37	24 26	29 03	- 2199	19
76	53 06	-3 82	21 42	29 74	- 0195	17
77	44 53	4 53	18 22	25 67	1275	15
78	40 36	5 43	20 17	25 53	1446	14
79	38 85	7 31	19 34	25 76	1006	13
80	35 00	8 00	20 74	25 6:	0856	13
81	31 77	8 31	21 88	26 09	1078	13
82	29 08	' 54	22 83	26 91	1651	13
83	27 38	6 46	23 76	7 80	2594	13
84	26 46	4 54	25 38	28 61	3649	13
85	26 46	1 85	27 98	28 77	4775	13
86	38 12	4 12	24 34	27 74	3932	8
87	39 00	-5 43	30 02	25 98	1588	7
88	31 25	50	35 30	15 96	9355	4

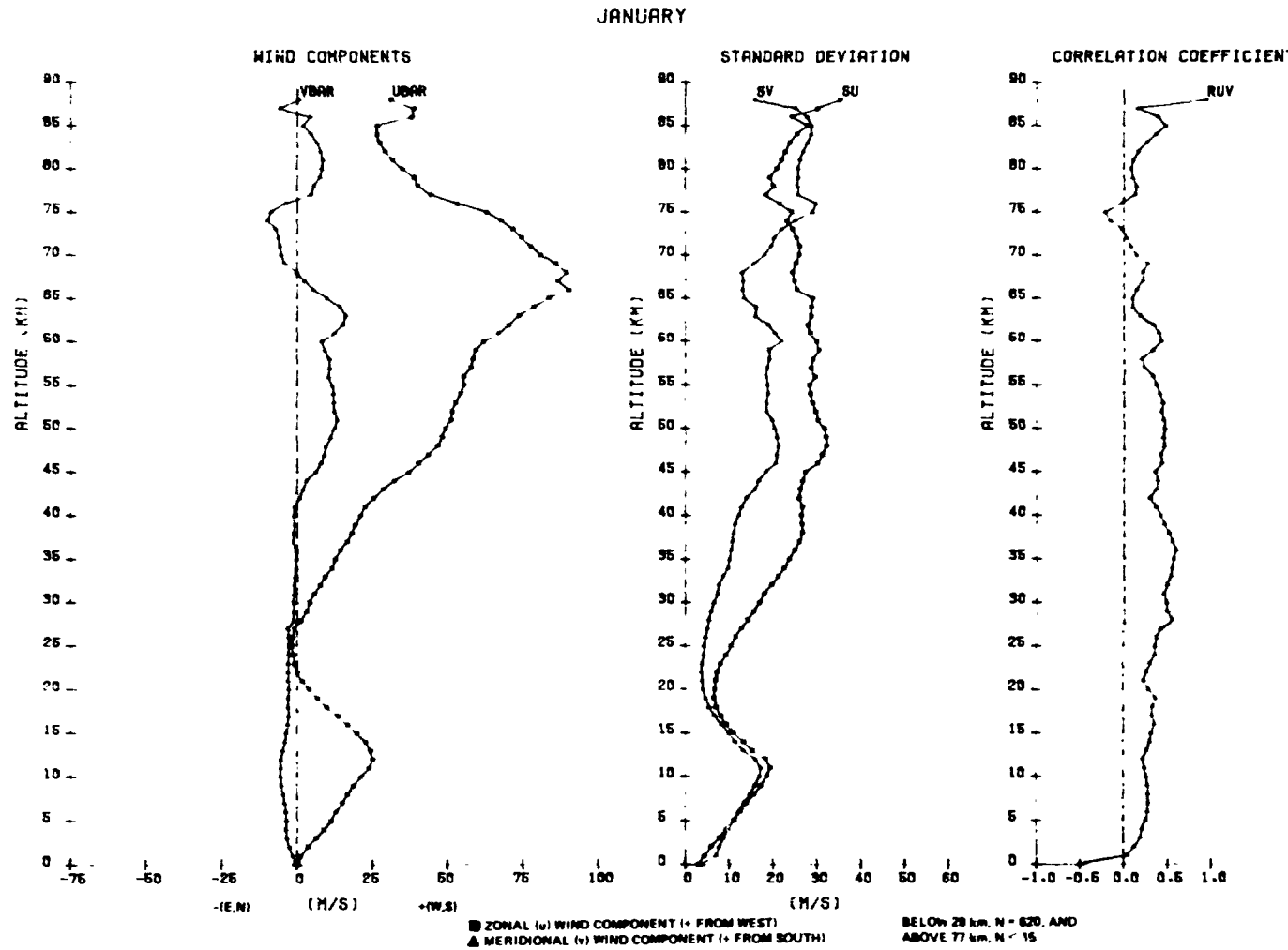

Figure 2.1. VAFB bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 2.2. VAFB BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

February

Alt (km)	$\bar{u}$	$\bar{v}$	S(u)	S(v)	R(uv)	N
0	69	- 78	3 65	3 49	- 9499	964
1	23	-1 60	4 28	7 38	- 1941	964
2	2 24	-2 02	5 25	8 58	- 1149	964
3	4 96	-2 87	6 69	9 76	- 0159	964
4	7 48	-3 14	8 65	10 85	0041	964
5	9 76	-3 18	9 39	11 80	0215	964
6	11 69	-3 20	10 59	12 91	0738	964
7	13 87	-3 38	12 12	14 21	1126	964
8	16 25	-3 75	13 67	15 40	1636	964
9	18 84	-4 15	15 55	16 92	1818	964
10	21 43	-4 34	17 56	17 44	2138	964
11	24 40	-4 08	18 63	17 10	2311	964
12	26 28	-3 50	17 26	15 75	2387	964
13	25 44	-2 88	14 65	13 26	2665	964
14	23 55	-2 51	12 55	11 53	2398	964
15	20 49	-2 43	10 09	9 69	2340	964
16	17 59	-2 22	8 52	8 40	2630	964
17	14 25	-2 26	7 29	6 81	2425	964
18	10 58	-2 23	6 32	5 49	2277	964
19	7 35	-2 25	5 90	4 45	2566	964
20	4 62	-2 11	6 85	3 83	2503	964
21	2 46	-2 00	6 28	3 58	2192	964
22	1 13	-2 29	6 72	3 32	1856	964
23	34	-2 11	7 08	3 29	1576	964
24	07	-1 97	7 71	3 50	1223	964
25	- 13	-1 90	8 56	3 57	1103	964
26	40	-1 80	9 66	4 02	1466	964
27	1 58	-1 69	11 30	4 38	1503	964
28	39	1 77	12 21	3 69	0705	117
29	1 53	-1 89	13 33	3 99	1120	119
30	2 68	-1 98	14 62	4 46	2525	126
31	4 96	-1 67	16 67	4 66	3372	127
32	7 20	-1 49	18 45	5 06	3546	124
33	9 54	95	20 19	5 68	3730	125
34	11 78	73	22 62	5 96	4892	127
35	14 50	41	24 73	6 66	5270	127
36	17 01	- 82	26 84	6 93	5406	125
37	20 21	-1 00	28 23	7 31	5178	126
38	21 12	1 50	29 94	7 90	4968	126
39	23 33	-1 47	30 57	9 00	4197	129
40	25 03	-1 93	30 76	10 12	3929	127
41	27 30	-1 19	31 13	11 76	4238	126
42	29 41	-1 25	31 45	12 58	4453	128
43	30 95	26	31 53	13 74	4831	129
44	32 41	1 28	31 78	15 27	4972	128
45	34 23	2 21	31 77	16 32	4914	126
46	34 95	2 72	31 75	15 96	4543	128
47	36 33	4 38	31 72	15 43	4788	128
48	35 87	4 74	30 62	14 15	4412	123
49	38 46	4 49	29 42	12 90	4716	126
50	38 65	5 28	28 39	14 90	3739	127
51	39 55	5 52	27 92	15 55	3701	125
52	40 92	5 97	27 02	14 42	3774	127
53	42 07	6 11	26 79	14 14	3879	124
54	45 57	6 24	25 21	14 77	4245	118
55	47 50	7 42	25 35	14 29	4261	117
56	49 17	7 01	25 56	15 27	3558	114
57	51 50	8 36	24 60	14 48	2870	107
58	54 67	8 28	24 65	14 79	3940	99
59	58 06	7 27	24 24	15 43	4403	78
60	61 19	5 65	23 06	17 52	4295	62
61	65 12	8 30	21 47	17 57	3797	40
62	67 28	5 06	24 77	17 39	4634	32
63	70 62	6 04	29 54	14 39	2584	26
64	71 96	3 80	30 45	13 47	1697	25
65	71 87	3 22	31 11	13 43	0747	23
66	71 09	3 65	30 96	13 64	0673	23
67	71 09	3 22	32 76	12 68	0163	23
68	68 91	2 64	33 26	12 47	1103	22
69	67 05	41	30 20	15 86	- 3582	22
70	63 95	-1 25	24 37	17 99	1467	20
71	62 38	-2 10	25 75	15 25	- 1312	21
72	57 90	2 43	26 19	12 82	- 3812	21
73	54 06	-1 76	27 02	14 20	- 5893	17
74	45 40	13	26 95	17 55	6617	15
75	35 42	7 83	25 35	17 48	- 7542	12
76	30 25	11 88	24 35	17 34	- 7052	12
77	28 00	13 10	24 20	18 53	- 5989	10
78	24 00	15 60	23 72	18 18	- 4283	10
79	21 10	17 90	24 18	17 65	- 2019	10
80	18 99	19 60	24 88	17 30	0002	10
81	14 44	20 33	25 43	17 49	1594	9
82	14 11	21 00	26 46	17 20	2928	9
83	14 56	20 56	27 71	16 61	3709	9
84	16 11	18 89	28 98	15 79	3703	9
85	18 89	16 11	29 13	15 33	3033	9
86	19 25	12 25	25 86	18 58	7541	4
87	25 75	2 75	24 99	22 53	- 7756	4
88	24 00	12 67	23 37	12 42	- 9901	3

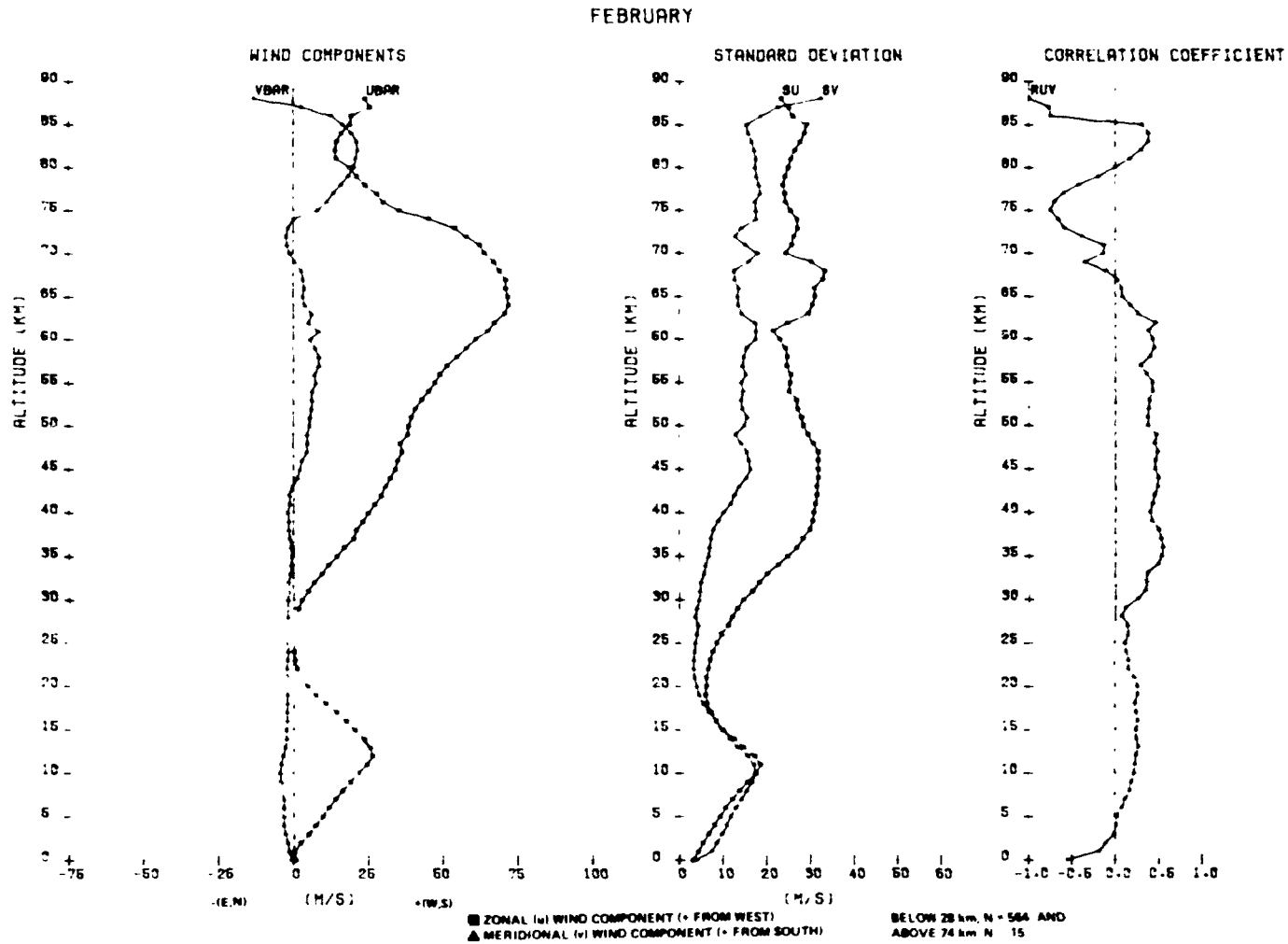

Figure 2.2. VAFB bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 2.3. VAFB BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

March

Alt (km)	$\bar{u}$	$\bar{v}$	S(u)	S(v)	R(uv)	N
0	1 03	-1 4	2 78	3 48	- 5763	620
1	1 13	-2 35	4 00	6 35	- 0862	620
2	3 21	-2 30	5 00	7 48	- 0330	620
3	6 08	-3 51	6 64	8 53	- 0176	620
4	8 42	-3 52	8 39	9 74	0439	620
5	11 05	-3 69	10 20	11 04	0475	620
6	13 19	-3 81	11 69	12 21	0694	620
7	15 20	-4 11	13 06	13 73	1363	620
8	17 17	-4 39	14 48	15 17	1792	620
9	19 97	-4 65	15 33	16 56	2137	620
10	21 43	-4 66	15 64	17 35	2276	620
11	23 2	-4 44	15 67	16 69	2201	620
12	2 02	-3 56	13 84	15 66	1966	620
13	24 75	-2 74	11 79	12 22	1699	620
14	23 32	-1 90	10 34	10 95	2158	620
15	26 81	-1 51	8 63	8 92	1693	620
16	18 03	-1 18	7 83	7 92	1355	620
17	15 26	-1 36	7 20	6 58	0862	620
18	11 78	-1 20	6 40	5 01	0414	620
19	8 65	-1 26	6 09	4 18	0253	620
20	6 46	-1 38	6 24	3 83	- 0661	620
21	4 60	-1 27	6 72	3 48	- 0538	620
22	3 12	-1 07	7 07	3 08	- 0003	620
23	2 96	- 86	7 84	3 24	1132	620
24	3 30	- 54	8 74	3 29	1927	620
25	3 60	- 30	9 66	3 29	2329	620
26	4 42	- 18	10 36	3 27	3258	620
27	5 63	04	11 39	3 97	4227	620
28	4 12	45	10 54	3 66	4841	97
29	5 66	50	11 48	3 64	5027	101
30	7 84	47	12 20	4 18	6037	103
31	9 36	65	13 56	4 93	7614	107
32	11 87	86	14 89	5 17	2697	106
33	14 65	1 66	15 93	5 08	2237	107
34	17 74	2 35	16 98	5 98	2234	109
35	20 75	2 49	17 82	6 36	3077	110
36	23 65	2 65	19 16	6 93	3846	108
37	24 60	2 62	20 67	7 54	4387	108
38	28 97	2 31	22 16	7 48	4535	109
39	30 31	3 05	23 04	8 17	4256	111
40	31 75	3 97	23 50	8 78	3248	108
41	33 83	4 53	22 81	9 65	2417	110
42	35 09	4 91	21 47	10 34	2586	107
43	35 20	4 77	20 90	11 13	2896	111
44	35 41	5 97	20 60	11 80	3114	109
45	36 23	7 22	19 83	12 06	3221	111
46	36 29	9 05	19 03	11 62	3669	110
47	37 57	9 62	18 80	11 95	3204	111
48	38 19	9 54	18 22	11 93	2836	110
49	38 18	9 39	17 85	12 78	2941	109
50	37 92	9 59	17 76	13 00	3297	109
51	37 46	10 13	17 72	13 13	3199	109
52	37 09	10 94	17 70	13 40	3461	106
53	38 40	11 27	18 01	13 7	3407	108
54	38 52	11 66	17 33	13 56	3736	105
55	39 13	13 10	17 45	13 93	4062	100
56	40 28	13 28	18 67	13 93	3556	98
57	41 29	12 62	19 59	13 88	3040	93
58	41 64	11 20	20 40	13 99	3605	86
59	44 82	11 39	20 32	13 51	4005	66
60	44 30	8 51	20 78	15 04	4442	53
61	40 05	6 95	22 49	17 29	2463	44
62	42 45	6 06	21 18	17 29	3026	33
63	41 57	4 93	22 09	16 71	2345	30
64	39 52	3 39	23 67	17 24	2494	23
65	37 26	2 48	23 65	18 78	1766	23
66	36 00	1 27	22 17	21 63	1350	22
67	31 05	1 33	20 95	19 38	1135	21
68	26 32	2 79	22 61	18 04	1829	19
69	21 05	6 37	23 26	19 11	0362	19
70	18 40	7 05	23 91	16 22	0331	20
71	18 67	4 06	23 29	18 75	- 0043	18
72	17 65	6 94	23 69	18 15	0679	17
73	12 33	7 09	22 16	17 09	2065	15
74	13 92	8 67	17 37	18 88	3514	12
75	8 60	11 20	14 32	13 41	3379	10
76	5 25	11 75	15 86	13 63	3779	8
77	5 57	13 00	15 53	13 35	2219	7
78	50	14 17	11 79	14 64	1994	6
79	1 56	16 50	12 00	14 24	1438	6
80	40	17 80	14 92	14 84	5369	5
81	00	19 80	15 41	13 44	6074	5
82	80	22 20	17 47	11 99	6760	5
83	2 60	24 20	19 12	9 83	7351	5
84	5 60	25 80	20 42	8 03	8149	5
85	10 00	26 80	21 40	6 43	8515	5
86	12 00	25 67	27 58	7 13	9538	3
87	22 67	27 00	29 32	7 26	9118	3
88	34 67	27 67	31 75	7 13	7824	3

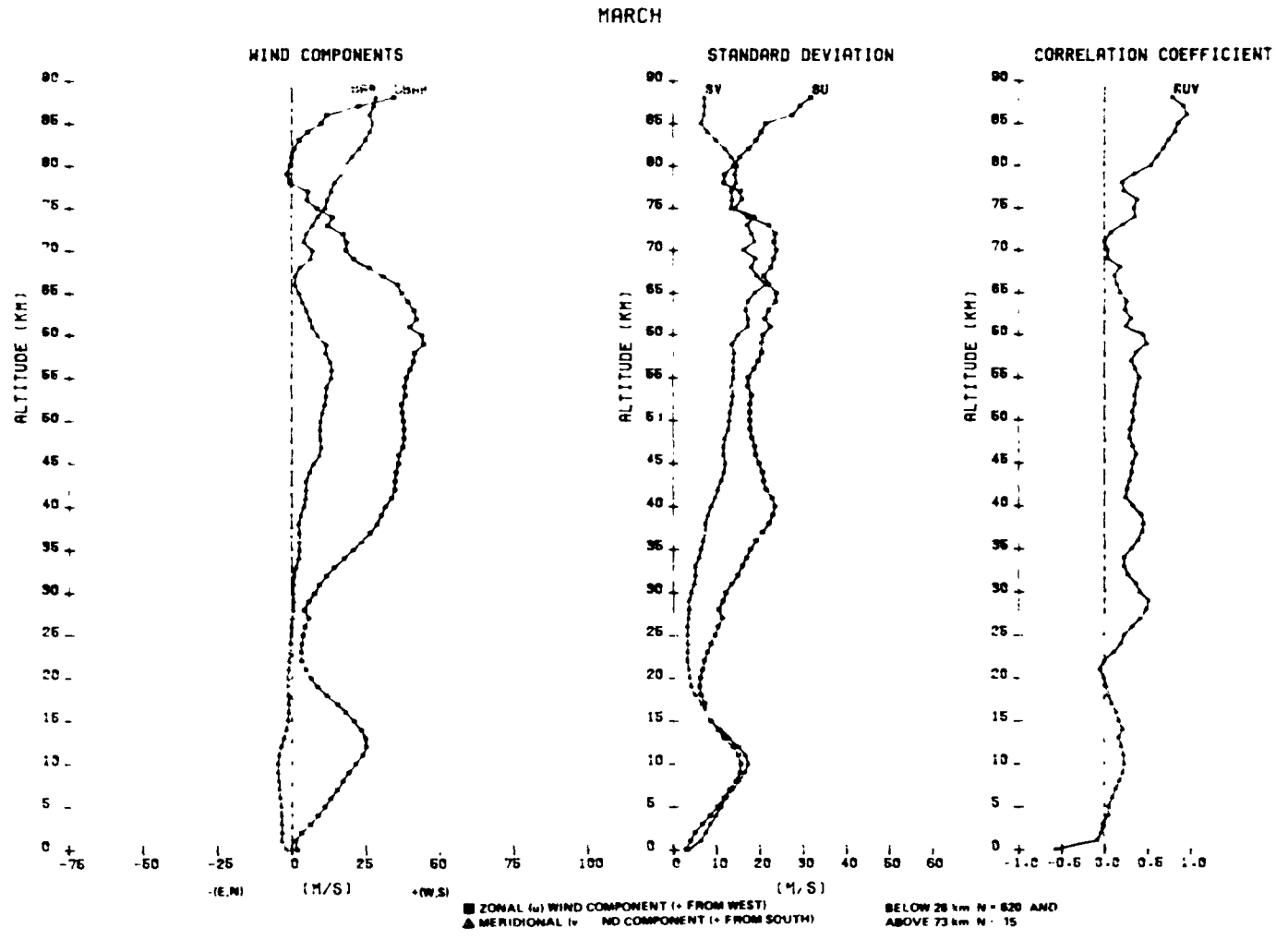

Figure 2.3. VAFB bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 2.4. VAFB BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

April

Alt (km)	$\bar{u}$	$\bar{v}$	S(u)	S(v)	R(uv)	N
0	2 22	-2 39	2 80	3 24	- 6305	600
1	1 31	-4 01	3 99	5 68	- 0877	600
2	2 83	-3 68	4 97	7 48	- 1282	600
3	5 61	-3 94	6 56	8 60	- 0255	600
4	8 55	-4 12	8 47	10 35	0371	600
5	11 34	-4 03	10 30	11 90	1063	600
6	13 91	-4 02	11 96	13 46	1403	600
7	16 45	-3 94	13 19	15 00	1773	600
8	18 19	-4 05	14 48	16 28	2183	600
9	20 00	-4 06	15 47	17 08	2739	600
10	21 87	-4 08	15 68	17 42	2879	600
11	23 20	-3 53	15 23	16 82	2802	600
12	23 94	-2 36	13 64	15 48	2544	600
13	23 32	-1 02	11 29	12 84	2311	600
14	21 55	25	9 14	10 85	2090	600
15	19 33	73	8 00	9 21	2190	600
16	16 36	81	6 98	7 79	1934	600
17	13 21	82	6 09	6 60	1087	600
18	10 04	93	5 43	5 16	0843	600
19	7 01	76	4 74	4 13	0352	600
20	4 54	37	4 44	3 43	0413	600
21	2 95	29	4 48	3 14	1350	600
22	1 69	04	4 58	2 82	1862	600
23	1 25	09	4 82	2 54	2015	600
24	1 68	01	5 09	2 58	2060	600
25	2 50	- 10	5 66	2 91	1852	600
26	3 14	- 13	6 05	3 02	2909	600
27	4 38	00	6 58	3 32	2794	600
28	3 89	83	6 38	2 96	2854	107
29	5 61	85	6 84	3 31	3894	108
30	7 40	55	7 19	3 93	3145	109
31	9 22	56	7 40	4 24	1665	115
32	10 93	82	8 09	4 93	3232	118
33	13 08	1 02	8 54	5 53	3241	118
34	14 76	94	9 16	5 43	3390	119
35	16 19	98	9 58	5 40	3518	121
36	17 49	1 22	10 60	5 77	4325	122
37	18 58	77	11 69	6 05	4640	120
38	18 87	21	12 82	7 36	3667	122
39	18 50	- 67	14 05	7 32	3629	122
40	17 52	-1 14	15 77	6 85	3361	123
41	15 34	- 53	16 74	6 74	1837	122
42	13 67	88	16 77	7 80	- 0190	121
43	12 48	2 83	16 29	8 20	0713	119
44	12 45	3 87	16 23	8 32	1395	120
45	12 08	4 37	16 57	7 65	1826	118
46	12 75	5 02	17 11	8 40	2621	118
47	12 68	5 24	18 26	7 92	3303	119
48	12 04	5 87	18 97	7 39	2388	121
49	12 31	6 22	18 96	7 42	1365	121
50	12 52	5 53	18 53	7 99	1835	118
51	11 56	5 55	19 21	7 56	2121	120
52	10 24	5 38	19 03	7 17	1861	119
53	8 57	5 17	18 74	7 75	2605	115
54	6 83	4 80	18 89	8 63	2946	117
55	5 72	5 75	19 12	8 07	2174	115
56	5 12	6 88	18 86	8 37	2441	110
57	4 99	7 08	18 10	8 37	2539	106
58	4 89	6 07	17 18	9 48	1987	101
59	4 36	4 47	18 13	10 70	3545	81
60	1 92	2 77	19 48	10 05	2893	66
61	10	2 54	18 07	8 45	0829	48
62	16	4 10	16 65	9 11	2303	31
63	- 03	4 93	15 82	12 12	1347	29
64	-1 35	5 77	15 40	11 46	- 0536	26
65	-3 27	5 36	14 34	10 76	- 2352	22
66	29	4 75	15 58	12 00	- 4224	24
67	1 46	3 25	10 90	12 76	- 3824	24
68	1 62	43	8 86	12 10	0 5	21
69	- 35	-2 00	11 09	10 56	3052	23
70	-1 26	-2 91	13 20	9 11	1699	23
71	-2 48	-4 09	12 86	10 69	- 0044	23
72	-4 96	-4 7x	12 93	12 39	1169	23
73	-8 38	-5 24	15 09	13 65	1444	21
74	-8 41	-5 47	13 16	15 99	3001	17
75	-12 60	-3 13	14 26	17 26	4606	15
76	-15 80	-2 53	14 91	18 07	4547	15
77	-18 60	-2 07	15 41	18 17	4214	15
78	-21 07	-1 47	15 87	18 68	4064	15
79	-23 00	- 40	15 92	19 55	4028	15
80	-24 13	1 13	15 82	20 56	4041	15
81	-25 43	1 07	15 44	20 57	4249	14
82	-24 29	2 79	15 54	20 48	5563	14
83	-21 93	4 71	16 31	19 80	7188	14
84	-18 00	6 64	17 76	18 16	8055	14
85	-12 79	8 43	19 77	15 84	8639	14
86	-10 78	10 33	20 64	11 40	3888	9
87	-5 63	10 75	22 19	12 32	7872	8
88	2 43	10 29	22 90	13 45	7082	7
89	10 83	11 17	23 42	17 20	6120	6
90	12 00	11 60	18 28	21 46	8082	5

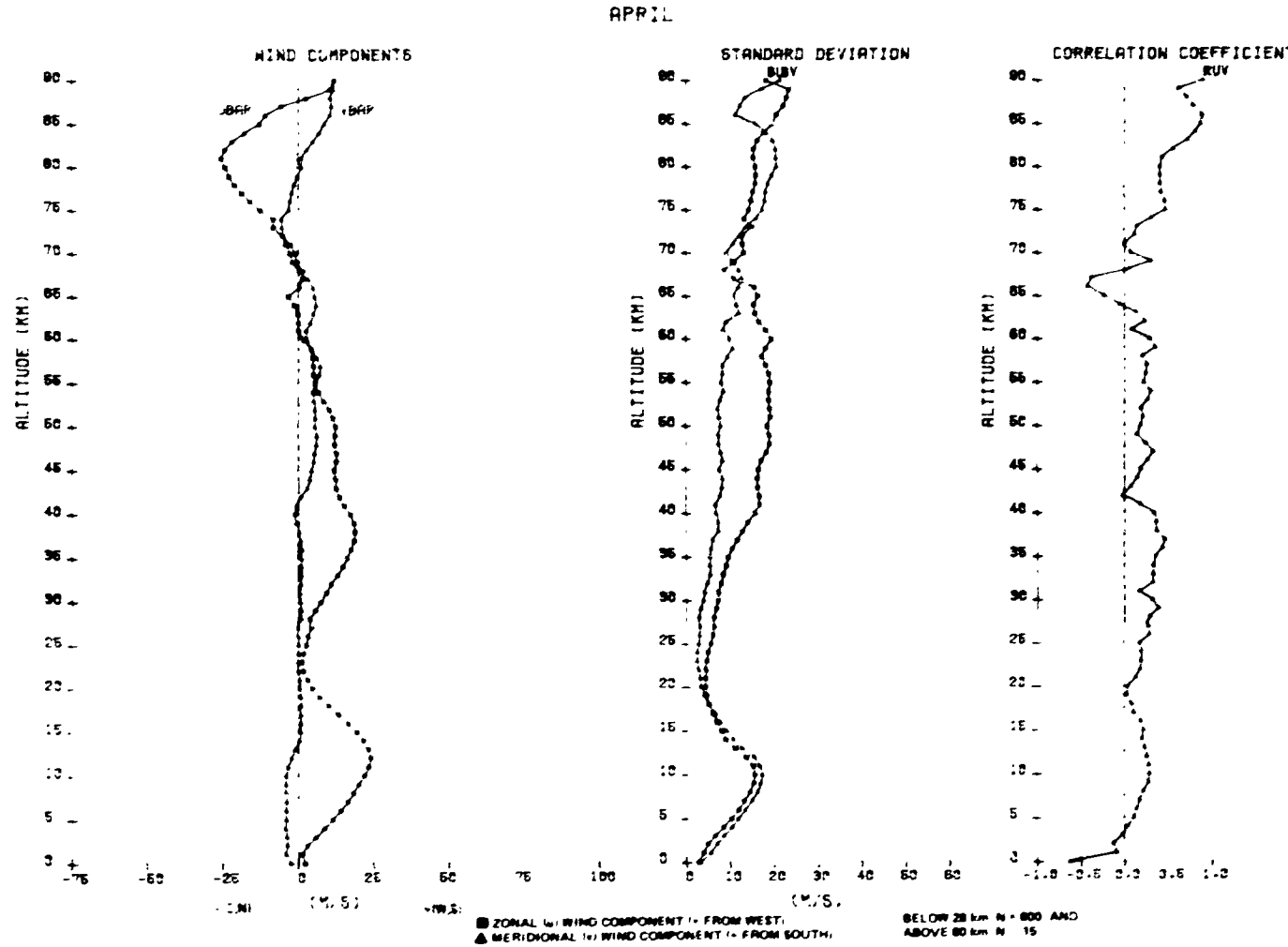

Figure 2.4. VAFB bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 2.5. VAFB BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH.

May

Alt (km)	$\bar{u}$	$\bar{v}$	S(u)	S(v)	R(uv)	N
0	2 32	-2 15	2 39	2 39	- 6069	620
1	1 02	-3 93	3 43	4 41	- 1995	620
2	1 02	-3 13	4 10	5 43	- 3577	620
3	2 72	-2 57	5 90	6 53	- 4074	620
4	4 54	-2 20	7 29	7 45	- 3226	620
5	6 17	-2 01	8 44	8 09	- 1763	620
6	7 48	-2 05	9 54	9 04	- 0695	620
7	8 73	-2 29	10 63	10 32	- 0016	620
8	10 06	-2 56	11 72	11 78	0601	620
9	11 27	-2 44	12 61	12 78	1322	620
10	12 72	-2 30	13 43	13 98	1951	620
11	14 09	-2 07	14 04	14 05	2578	620
12	15 08	-1 25	13 20	12 82	2846	620
13	15 31	00	11 17	10 61	2797	620
14	14 75	91	8 93	8 59	2104	620
15	13 22	1 45	7 00	6 84	1718	620
16	11 17	1 61	5 80	5 69	1725	620
17	8 59	1 43	4 09	4 37	1054	620
18	5 57	1 05	3 95	3 45	1232	620
19	2 67	64	3 62	2 73	0947	620
20	22	04	3 42	2 31	1000	620
21	-1 40	- 36	3 40	2 46	1441	620
22	-2 36	- 51	3 32	2 22	0733	620
23	-2 79	- 65	3 65	2 28	1021	620
24	-2 69	- 75	4 08	2 33	0703	620
25	-2 60	- 68	4 26	2 31	0838	620
26	-2 31	- 59	4 67	2 49	0151	620
27	-1 73	- 58	5 19	2 88	0242	620
28	-2 12	44	4 18	2 33	0993	116
29	-1 39	43	4 34	2 51	1080	116
30	- 75	82	4 80	2 80	0581	118
31	- 89	1 13	5 29	3 12	0653	123
32	- 51	1 55	5 53	3 29	- 0022	127
33	- 16	1 66	5 65	3 59	1116	128
34	- 03	1 91	6 02	3 64	2013	128
35	- 53	1 21	6 43	3 46	1488	129
36	-1 63	69	7 47	3 49	0433	126
37	2 85	28	7 74	3 82	- 0438	126
38	-3 86	23	7 97	4 07	0086	129
39	-5 65	16	8 42	3 78	- 0970	129
40	-7 00	29	8 41	4 38	- 3090	127
41	-9 02	28	8 12	4 13	- 1710	127
42	-10 28	29	8 52	4 12	- 1388	125
43	-12 21	34	8 34	4 53	- 1659	126
44	-14 01	1 66	7 61	4 65	- 0976	128
45	-15 30	3 33	8 00	5 25	1677	129
46	-16 62	4 29	8 36	5 27	1575	124
47	-17 59	5 08	8 92	5 40	0878	128
48	-18 42	6 07	9 04	5 69	0973	126
49	-19 12	6 80	9 19	5 49	0995	128
50	-19 44	6 69	9 79	4 83	1392	126
51	-19 19	6 05	9 79	5 87	- 0859	126
52	-19 95	4 69	9 57	5 92	- 0495	124
53	-21 23	3 57	9 58	6 02	- 1028	122
54	-23 73	3 48	9 50	6 13	- 1917	122
55	-25 84	4 66	10 33	6 81	- 2764	116
56	-26 78	3 66	10 54	7 09	- 1983	107
57	-28 86	3 30	10 32	8 55	- 0185	106
58	-31 10	2 68	9 97	9 90	2130	92
59	-33 04	2 22	11 07	9 73	3032	77
60	-33 44	4 19	11 50	10 78	2326	54
61	-32 86	6 95	14 15	10 44	3749	42
62	-35 12	5 32	13 89	10 29	4887	34
63	-34 41	4 23	13 89	8 54	2650	22
64	-35 00	2 91	13 66	11 32	0191	23
65	-34 17	4 04	14 30	9 84	0365	23
66	-33 87	4 65	13 89	8 16	- 3145	23
67	-32 77	5 55	11 66	10 69	- 2698	22
68	-28 20	3 83	12 72	12 48	- 0462	20
69	-23 85	4 25	7 62	12 82	0405	20
70	-23 81	1 00	10 85	10 90	2599	21
71	-22 29	1 96	13 11	10 29	0731	24
72	-20 74	- 39	16 38	12 92	1042	23
73	-19 17	-6 35	20 74	12 55	- 2430	23
74	-20 89	-11 47	20 61	14 18	- 2975	19
75	-23 47	-10 41	16 73	12 72	0111	17
76	-24 47	-10 20	17 02	14 66	1303	15
77	-24 69	-8 38	18 07	13 50	2490	13
78	-25 15	-7 69	18 70	13 33	3585	13
79	-25 62	-6 92	19 23	13 29	4570	13
80	-24 69	-5 85	19 81	12 96	4894	13
81	-22 77	-4 38	20 10	12 98	4554	13
82	-19 69	-3 08	19 24	13 35	3942	13
83	-15 15	-1 23	17 36	13 86	2906	13
84	-9 46	69	14 54	14 92	1965	13
85	-2 00	2 77	11 49	16 10	1190	13
86	7 50	- 83	7 63	14 10	2238	6
87	17 00	1 67	8 54	15 86	3382	6
88	26 25	-1 50	11 50	9 96	2957	4
89	35 25	2 25	13 14	13 83	4661	4
90	43 75	6 75	13 59	10 32	6504	4

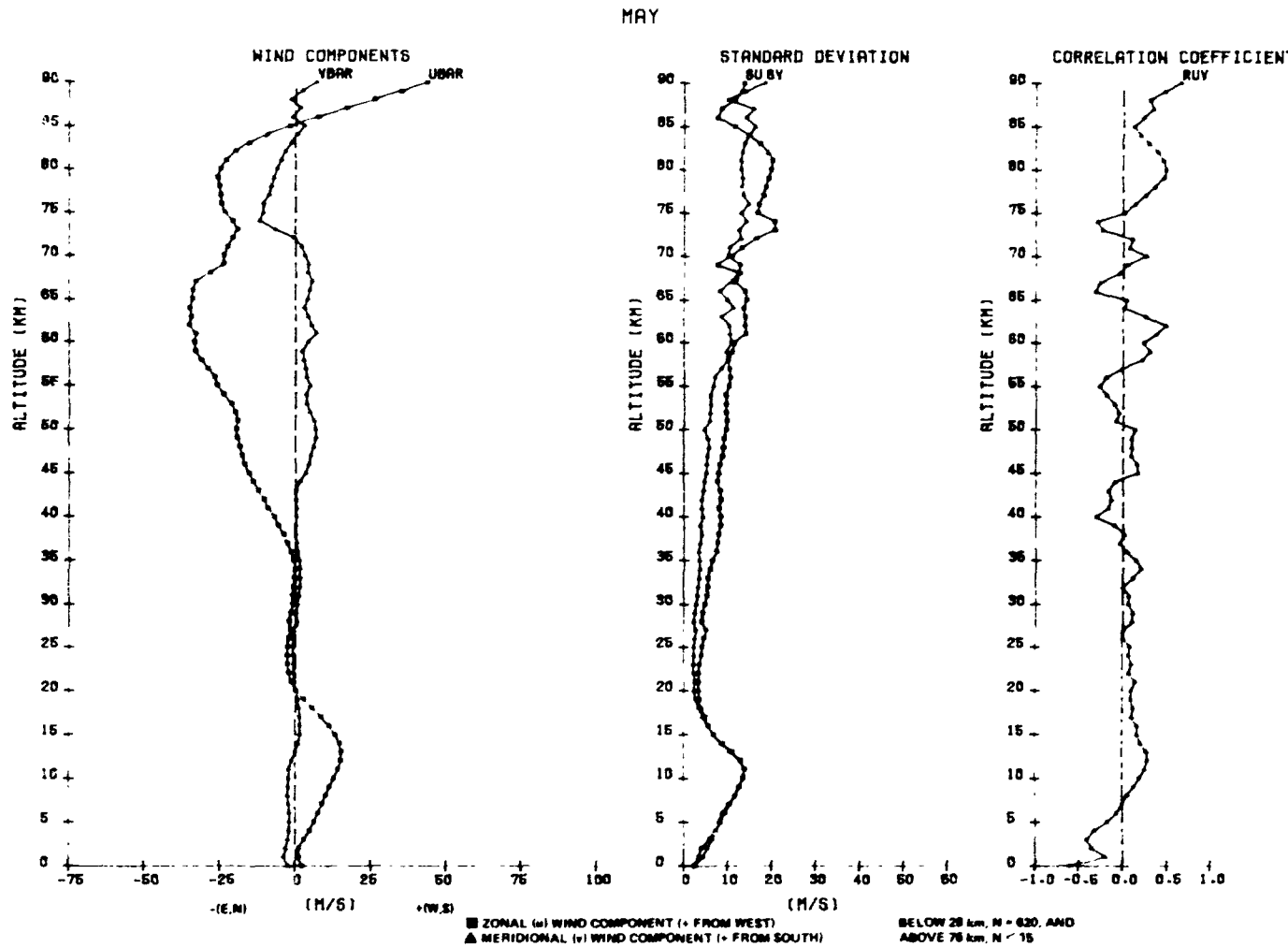

Figure 2.5. VAFB bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 2.6. VAFB BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

June

Alt (km)	$\bar{u}$	$\bar{v}$	S(u)	S(v)	R(uv)	N
0	2 42	-1 88	2 32	2 37	- 5661	600
1	80	-3 51	3 15	4 34	- 2355	600
2	80	-2 59	4 06	5 16	- 4029	600
3	2 41	-1 41	5 52	6 16	- 3349	600
4	3 90	- 52	6 70	6 94	- 2591	600
5	5 47	- 19	7 56	7 75	- 2119	600
6	6 94	02	8 51	8 90	- 1842	600
7	8 94	21	9 51	10 10	- 1565	600
8	10 15	17	10 83	11 78	- 1110	600
9	11 74	58	11 76	13 39	- 0905	600
10	13 52	94	12 42	14 62	- 0238	600
11	15 45	1 47	12 71	15 14	0228	600
12	17 4[illegible]	2 23	12 80	14 97	0656	600
13	17 24	3 04	11 55	13 03	0578	600
14	15 31	3 48	9 34	10 69	0754	600
15	12 35	3 20	7 48	8 20	0104	600
16	8 60	2 46	5 77	6 04	- 0654	600
17	4 77	1 67	4 75	4 51	- 0942	600
18	82	1 15	3 85	3 18	- 1412	600
19	-1 91	59	3 34	2 52	- 1005	600
20	-4 13	25	3 14	2 14	- 0373	600
21	-5 58	05	3 05	2 02	- 0693	600
22	-6 86	- 17	3 04	2 03	- 0372	600
23	-7 92	- 35	3 21	1 91	- 0250	600
24	-8 53	- 38	3 34	1 92	- 0451	600
25	-9 35	- 31	3 57	2 03	- 0514	600
26	-9 88	- 18	3 80	2 16	- 1081	600
27	-10 08	- 20	3 87	2 15	- 0108	600
28	-12 33	74	3 94	1 97	0896	102
29	-12 63	72	4 06	1 99	0827	103
30	-13 22	84	4 41	2 17	1089	107
31	-13 84	94	4 92	2 25	- 0319	108
32	-14 93	1 06	4 85	2 54	- 0879	112
33	-15 34	1 18	5 36	2 58	0212	112
34	-16 42	1 56	5 34	2 72	- 1340	111
35	-17 22	1 09	5 55	2 43	- 0078	112
36	-18 52	53	5 59	2 94	- 0780	112
37	-20 52	38	5 53	3 43	- 0225	109
38	-22 29	40	5 28	3 48	1294	111
39	-24 33	30	5 39	3 50	1211	108
40	-26 17	52	5 79	3 26	0166	107
41	-28 10	06	6 76	3 68	0204	110
42	-30 14	43	6 34	4 50	- 0959	110
43	-31 95	1 58	6 09	4 93	- 1037	110
44	-33 39	2 98	5 98	4 91	- 1331	107
45	-34 55	3 89	5 84	4 71	- 0945	109
46	-36 17	4 56	6 25	4 89	0218	109
47	-37 62	4 72	6 97	4 93	0664	110
48	-38 50	4 67	7 27	5 39	1189	108
49	-40 21	4 79	7 75	5 77	0700	108
50	-41 69	5 26	8 30	6 35	- 0170	108
51	-43 31	6 18	8 04	6 48	0358	102
52	-44 80	6 27	8 89	5 89	1756	97
53	-45 99	5 70	8 85	5 39	0653	93
54	-47 55	4 76	9 67	5 75	- 0757	91
55	-49 28	4 60	9 74	6 35	- 1283	87
56	-51 18	4 92	10 04	5 87	- 0965	84
57	-52 46	3 84	11 24	6 69	- 0096	74
58	-54 86	2 73	11 15	7 32	1519	59
59	-55 89	1 78	11 15	7 25	0770	45
60	-57 26	49	12 09	8 30	2291	35
61	-59 96	92	12 05	10 85	- 0245	24
62	-66 19	2 25	12 38	16 39	- 0577	16
63	-70 08	5 00	13 69	15 58	0011	13
64	-67 74	6 40	15 31	14 95	6320	10
65	-62 44	10 00	12 03	6 53	6307	9
66	-57 67	10 56	6 36	2 22	- 5649	9
67	-51 67	10 22	9 15	7 52	0909	9
68	-42 33	13 17	16 67	12 32	0043	6
69	-38 00	12 50	18 79	14 06	2318	8
70	-37 86	13 43	20 20	13 94	0855	7
71	-37 86	12 00	20 86	15 65	- 3715	7
72	-39 00	9 29	20 23	18 99	- 6072	7
73	-39 71	5 71	19 34	20 97	- 5560	7
74	-35 83	8 17	19 78	18 18	- 7246	6
75	-32 83	4 67	17 78	18 14	- 5813	6
76	-29 67	2 50	15 63	17 43	- 4533	6
77	-28 33	50	14 37	16 36	- 4431	6
78	-29 17	-1 00	12 68	14 65	- 5149	6
79	-28 80	-3 40	11 62	14 47	- 6003	5
80	-29 40	-3 60	9 69	13 05	- 6529	5
81	-29 60	-3 20	7 14	11 65	- 7311	5
82	-29 00	-3 00	6 60	10 14	- 7409	5
83	-27 40	-2 00	7 34	8 88	- 6356	5
84	-25 00	- 20	9 44	7 08	- 7236	5
85	-20 60	1 80	10 95	6 68	- 8254	5
86	-22 33	9 33	6 65	67	- 6025	3

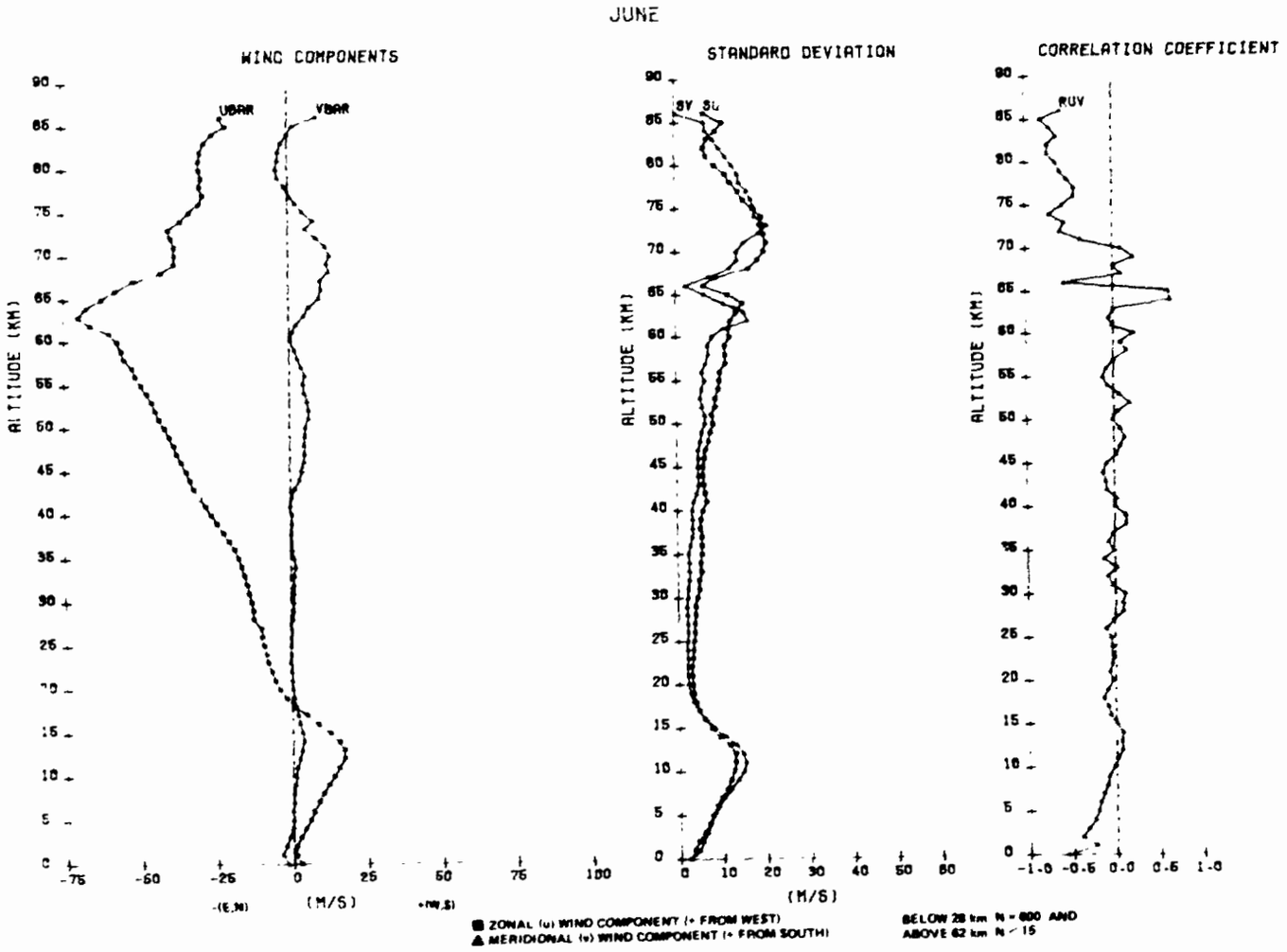

Figure 2.6. VAFB bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 2.7. VAFB BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

July

Alt (km)	$\bar{u}$	$\bar{v}$	S(u)	S(v)	R(uv)	N
0	2 03	-1 61	1 93	1 82	- 4607	620
1	25	-1 90	2 54	3 07	- 2064	620
2	- 25	- 16	3 04	3 92	- 1869	620
3	88	1 60	4 03	4 32	- 1257	620
4	1 76	2 82	4 86	4 66	0035	620
5	2 26	3 40	5 46	4 83	0642	620
6	2 90	3 94	6 24	5 29	0861	620
7	3 83	4 72	6 98	6 08	0503	620
8	5 03	5 86	7 90	6 95	0402	620
9	6 17	7 29	8 72	7 80	0001	620
10	7 28	9 00	9 47	8 60	- 0109	620
11	8 53	10 92	9 98	9 35	- 0191	620
12	9 46	12 23	9 98	9 69	- 0163	620
13	9 65	12 21	9 54	9 29	0354	620
14	8 59	11 05	8 47	8 28	1050	620
15	6 15	8 55	7 07	6 18	1610	620
16	2 64	5 89	5 19	4 63	1318	620
17	- 71	3 09	3 93	3 57	2216	620
18	-3 43	2 26	3 29	2 78	2395	620
19	-5 61	1 43	2 71	2 13	1653	620
20	-7 34	85	2 49	1 99	1657	620
21	-9 10	44	2 49	1 99	0821	620
22	-10 66	10	2 43	1 99	0760	620
23	-11 96	- 12	2 54	2 00	0085	620
24	-13 25	- 17	2 61	2 12	0240	620
25	-14 36	06	2 76	2 09	0014	620
26	-15 11	25	2 88	2 11	0669	620
27	-15 58	15	3 03	2 17	0456	620
28	-19 11	11	3 38	2 25	- 0097	94
29	-20 29	04	3 38	2 48	- 0823	97
30	-21 55	18	3 43	2 39	- 0422	101
31	-22 25	64	3 55	2 47	- 0375	104
32	-22 84	1 23	3 68	2 70	- 2192	106
33	-23 46	1 57	3 26	2 90	- 0749	106
34	-24 06	1 33	3 48	3 09	- 0253	107
35	-24 90	79	4 18	3 30	0198	107
36	-26 35	1 13	4 43	3 44	- 0830	110
37	-27 69	1 11	4 88	3 53	- 1381	108
38	-29 02	1 17	5 07	4 25	- 1775	109
39	-30 62	49	4 59	3 99	- 0286	107
40	-3. 05	04	4 21	4 44	- 0276	108
41	-35 54	- 23	4 34	5 07	0997	109
42	-37 88	- 19	4 99	5 29	1510	107
43	-40 41	31	5 39	5 54	1417	109
44	-41 96	2 01	5 52	5 87	0613	109
45	-43 64	3 27	5 60	5 44	0489	107
46	-44 57	4 10	6 07	5 20	1344	108
47	-46 00	4 44	6 75	5 71	1801	105
48	-47 52	4 45	6 90	6 29	2254	106
49	-49 40	4 00	6 92	5 90	1944	107
50	-51 39	5 17	7 59	5 63	2488	105
51	-53 31	5 58	8 49	6 16	2050	106
52	-54 01	6 71	8 81	6 67	2925	100
53	-54 54	7 59	8 93	6 89	1842	98
54	-54 53	7 49	9 41	7 36	1331	97
55	-55 53	6 77	9 92	9 20	2014	91
56	-58 55	4 79	11 25	9 96	1319	91
57	-60 73	2 68	11 63	11 46	1282	82
58	-61 06	53	12 14	12 78	2108	72
59	-61 69	70	14 06	13 00	1816	61
60	-62 30	2 51	16 77	14 48	0693	47
61	-63 34	4 29	17 03	18 07	0136	38
62	-64 82	9 15	19 55	11 57	1036	33
63	-61 93	8 34	20 59	11 68	0527	29
64	-63 50	7 08	23 47	10 66	1710	26
65	-61 59	6 41	21 56	13 39	0952	27
66	-52 89	8 96	20 48	13 47	1283	27
67	-46 48	10 48	20 58	14 90	1038	25
68	-40 27	11 82	19 36	15 72	0554	22
69	-32 56	11 90	19 87	18 69	2531	24
70	-29 90	12 35	23 40	16 05	2602	20
71	-28 60	11 05	23 10	16 57	0236	20
72	-26 47	11 00	23 99	17 53	- 2058	19
73	-24 11	8 89	24 28	20 22	- 4865	18
74	-22 94	7 59	24 42	25 17	- 5938	17
75	-20 00	2 56	23 17	26 61	- 5001	16
76	-20 06	- 13	23 21	28 44	- 4357	16
77	-20 20	-2 33	24 18	29 82	- 3646	15
78	-19 73	-4 47	24 27	29 18	- 2964	15
79	-19 13	-6 13	23 86	28 03	- 2276	15
80	-17 93	-7 20	22 73	26 61	- 1851	15
81	-16 33	-7 80	21 10	24 87	- 1278	15
82	-13 93	-8 13	19 00	23 38	- 0680	15
83	-10 47	-7 87	16 97	22 18	0175	15
84	5 80	-7 27	15 04	21 31	1098	15
85	- 07	-6 20	14 07	20 86	2206	15
86	6 71	7 00	12 58	23 11	5795	7
87	16 83	14 83	12 35	20 36	3009	6
88	20 50	22 00	13 61	14 54	3903	4
89	21 67	25 00	9 98	15 77	7796	3
90	27 33	25 33	7 41	13 57	6983	3

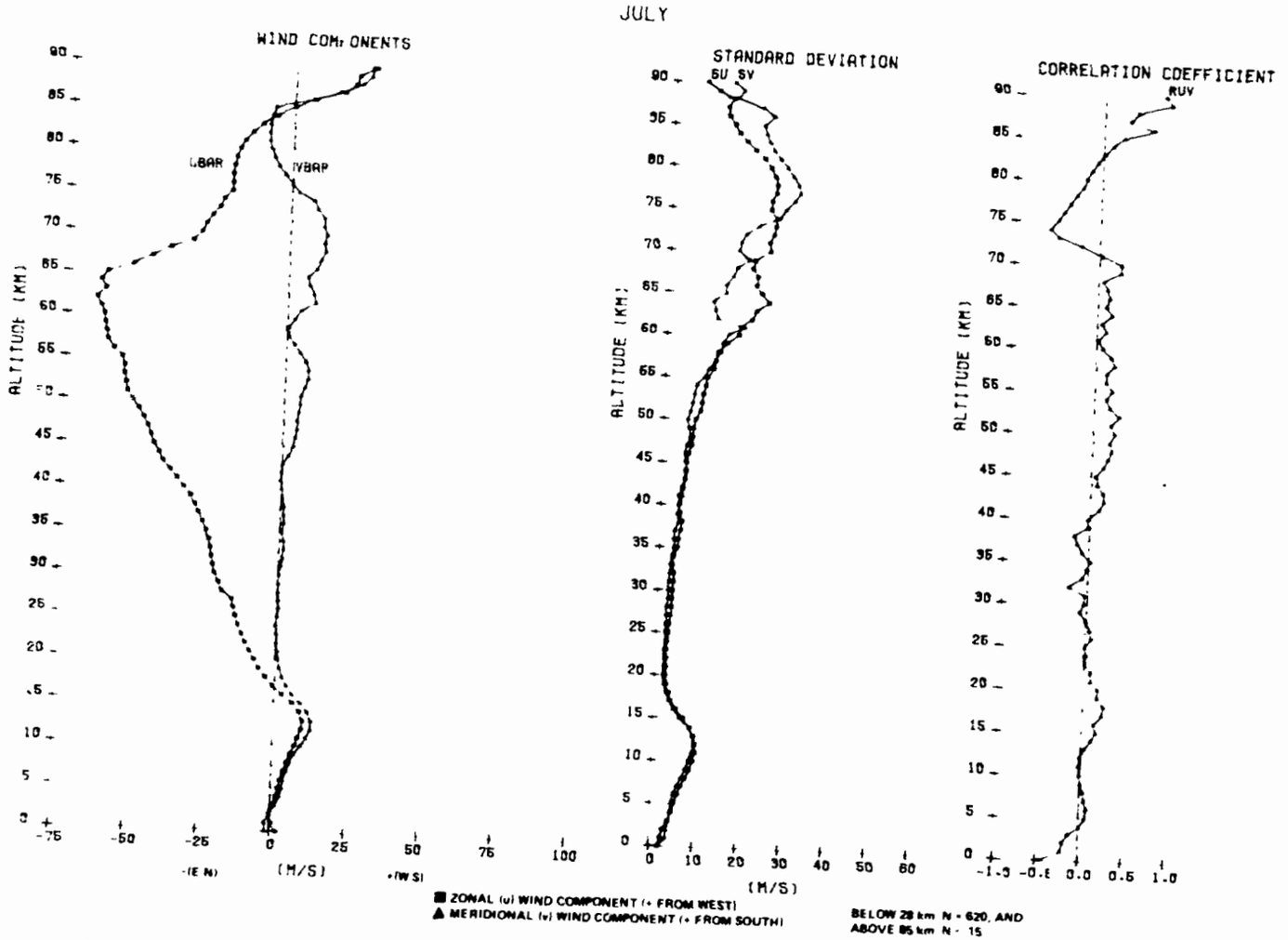

Figure 2.7. VAFB bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 2.8. VAFB BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

August

Alt (km)	$\bar{u}$	$\bar{v}$	S(u)	S(v)	R(uv)	N
0	2 90	-1 91	2 07	1 85	- 5696	620
1	46	-2 02	2 60	3 99	- 2910	620
2	02	- 34	3 15	4 19	- 2870	620
3	1 15	1 23	3 87	4 30	- 2645	620
4	1 77	2 16	4 55	4 34	- 1722	620
5	2 50	2 47	5 41	4 76	- 1032	620
6	3 71	2 80	6 19	5 56	- 0499	620
7	5 07	3 34	6 [illegible]	6 [illegible]	0147	620
8	6 62	3 99	7 42	7 27	0032	620
9	8 28	4 96	8 20	7 89	- 0305	620
10	9 88	6 16	8 96	8 36	- 0142	620
11	11 36	7 40	9 56	8 97	- 0043	620
12	12 27	8 32	9 68	9 09	0040	620
13	12 07	8 58	9 16	8 67	- 0067	620
14	10 59	7 60	7 79	7 66	0147	620
15	7 79	6 27	6 40	6 05	0235	620
16	4 15	4 48	5 35	4 62	- 0065	620
17	34	2 92	4 34	3 61	0931	620
18	-2 68	1 69	3 59	2 79	0720	620
19	-5 02	1 05	3 18	2 25	0069	620
20	-7 02	57	2 82	2 15	- 0997	620
21	-8 50	36	2 76	1 93	- 0120	620
22	-10 21	04	2 87	1 50	- 0378	620
23	-11 58	04	2 89	1 84	- 0706	620
24	-12 61	08	2 90	2 00	- 1701	620
25	-13 81	00	2 92	2 00	- 1474	620
26	-14 57	- 06	2 99	1 95	- 0862	620
27	-15 14	- 02	3 18	2 07	- 0372	620
28	-18 73	15	2 99	2 27	0200	74
29	-19 74	12	3 13	2 56	2035	74
30	-21 02	07	3 64	2 77	0908	82
31	-21 25	1 16	3 76	2 83	0605	88
32	-20 83	1 63	3 66	2 87	1308	90
33	-21 18	1 65	4 24	3 21	2049	97
34	-21 60	1 38	5 10	2 66	3063	91
35	-22 47	1 04	5 56	2 72	2754	96
36	-23 15	63	5 52	3 12	0314	92
37	-24 34	02	6 12	3 52	0364	94
38	-25 67	- 16	6 63	3 96	- 0778	93
39	-26 61	17	7 77	4 76	- 0272	95
40	-27 20	06	8 15	4 42	- 0017	96
41	-28 35	03	7 50	4 48	- 0075	95
42	-30 00	07	7 44	4 52	- 0172	95
43	-32 32	19	7 68	4 70	- 0303	96
44	-34 00	66	7 65	4 49	0217	95
45	-35 37	1 51	7 26	5 62	1044	98
46	-36 47	1 71	7 85	6 14	0497	98
47	-37 15	2 99	9 18	7 64	- 0659	98
48	-37 74	4 17	10 42	7 94	- 0701	98
49	-37 89	5 08	11 31	8 22	- 1606	97
50	-38 05	5 11	10 96	7 32	- 2040	95
51	-37 62	5 71	12 76	7 87	- 1721	95
52	-37 16	5 55	13 59	8 49	- 1428	94
53	-36 64	5 21	13 10	9 51	- 1579	92
54	-36 35	5 58	13 88	9 31	0429	92
55	-35 70	5 55	15 83	8 69	0897	91
56	-35 60	4 57	18 07	9 17	0080	90
57	-36 20	3 88	19 36	10 84	- 0156	91
58	-33 17	3 99	17 18	11 40	- 0551	77
59	-33 18	3 39	17 50	11 83	- 0694	69
60	-31 95	1 54	18 18	12 62	0639	57
61	-31 81	- 04	18 16	12 58	2043	48
62	-31 50	- 02	19 74	12 29	4299	40
63	-28 09	97	19 75	13 31	3136	32
64	-21 32	1 03	19 58	14 58	1872	34
65	-16 09	- 35	18 01	16 75	1308	34
66	-10 44	-1 31	17 07	19 64	3360	32
67	-8 19	-2 71	19 24	18 80	3584	31
68	-6 21	-1 57	22 07	18 66	4022	28
69	-5 23	-3 23	22 45	13 99	5797	30
70	-1 09	- 59	21 62	14 29	4398	32
71	2 14	48	20 35	12 92	3405	29
72	4 43	1 57	17 05	13 69	2607	28
73	5 52	1 37	14 72	14 46	3461	27
74	5 73	1 46	15 45	14 13	3891	26
75	5 17	- 87	17 58	12 93	3320	23
76	7 45	- 50	16 66	12 94	0885	20
77	6 65	-1 15	16 91	13 65	- 0130	20
78	5 40	-1 79	16 70	15 03	- 0931	20
79	4 45	-2 00	14 24	17 11	- 1279	20
80	2 89	-1 37	13 49	19 46	- 0773	19
81	2 53	-1 21	15 19	22 00	- 0386	19
82	2 11	- 68	16 11	24 80	0273	19
83	2 58	21	17 76	27 29	0572	19
84	4 21	1 79	18 99	30 03	0978	19
85	7 47	3 26	18 91	32 58	1796	19
86	14 75	6 92	21 64	38 25	4198	12
87	20 64	12 18	23 05	35 35	4302	11
88	26 87	22 37	25 50	29 72	5547	8

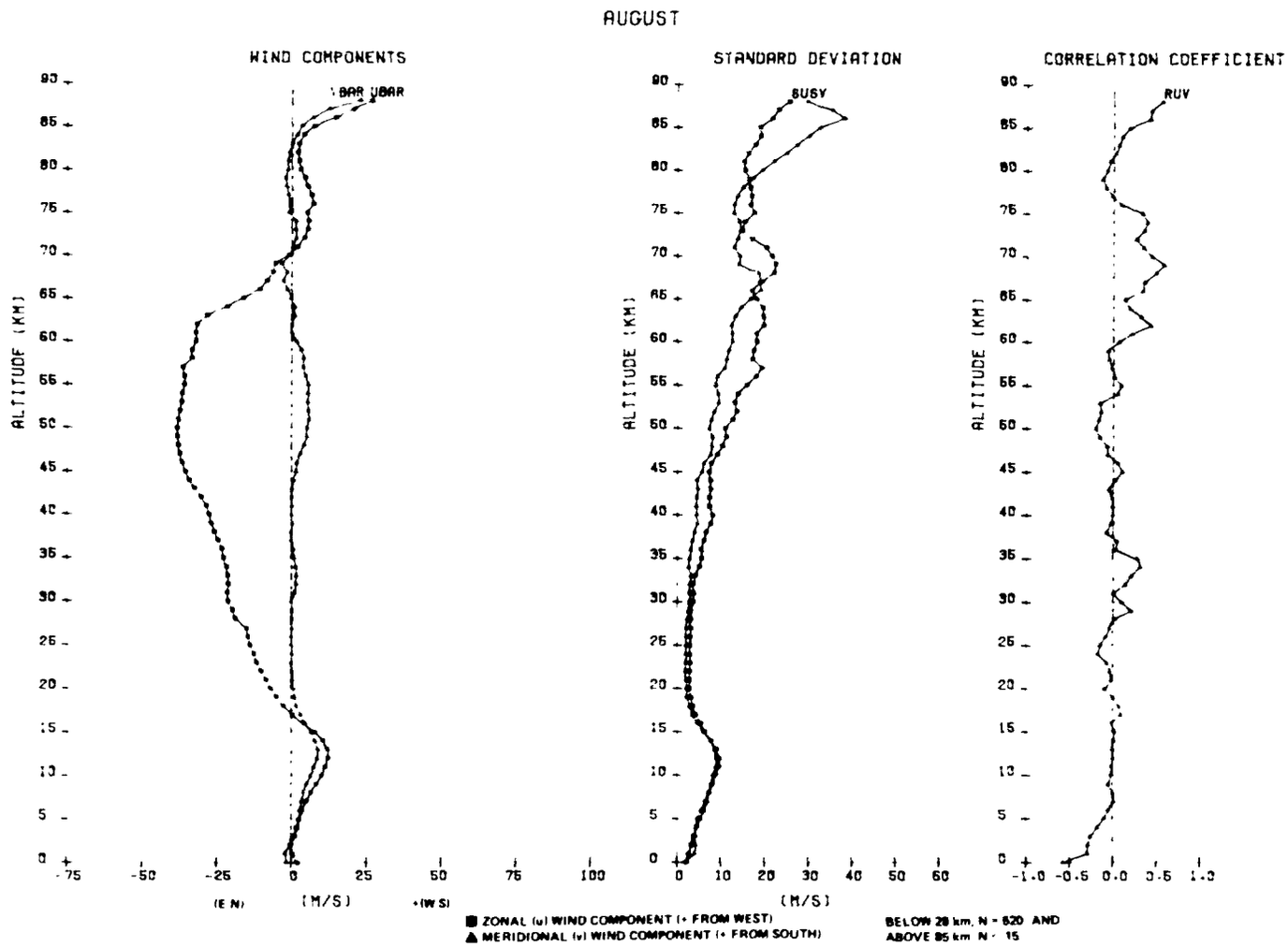

Figure 2.8. VAFB bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 2.9. VAFB BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

September

Alt (km)	$\bar{u}$	$\bar{v}$	S(u)	S(v)	R(uv)	N
0	1 71	-1 45	2 19	3 17	- 5912	600
1	- 32	-1 54	2 90	4 25	- 3485	600
2	- 48	- 25	4 66	5 04	- 3208	600
3	1 14	30	5 39	5 69	- 2310	600
4	2 43	45	6 54	6 37	- 1256	600
5	3 66	10	7 49	7 14	- 0982	600
6	4 81	- 25	8 37	8 17	- 0190	600
7	6 14	- 14	9 40	9 12	0670	600
8	7 71	- 13	10 45	10 22	1619	600
9	9 35	27	11 66	11 45	2510	600
10	11 37	69	12 82	12 25	3247	600
11	13 63	1 29	13 57	12 86	3833	600
12	15 50	2 03	13 28	12 38	3721	600
13	16 19	2 50	12 30	11 26	3442	600
14	15 62	2 24	10 01	9 51	2902	600
15	12 28	1 59	8 22	7 81	2518	600
16	8 93	1 41	7 15	6 82	2304	600
17	5 19	25	5 75	4 61	1666	600
18	2 04	- 23	4 88	3 47	1132	600
19	- 11	- 41	4 23	2 82	1320	600
20	-1 68	- 49	3 92	2 37	0757	600
21	-2 86	- 37	3 84	2 33	0791	600
22	-3 91	- 48	3 58	2 11	1565	600
23	-4 84	- 34	3 93	2 12	1601	600
24	-5 98	- 22	4 05	2 17	0451	600
25	-6 07	- 11	4 24	2 19	0983	600
26	-6 56	- 05	4 65	2 18	1020	600
27	-6 82	- 03	4 94	2 10	0696	600
28	-10 11	- 11	5 03	2 08	1565	81
29	-10 11	12	5 10	2 18	1293	82
30	-10 04	39	5 03	2 57	- 0281	85
31	-9 81	91	5 38	2 86	1028	90
32	-9 32	1 31	5 71	2 97	1567	90
33	-8 80	1 84	5 96	3 03	0969	90
34	-7 59	2 35	5 91	3 16	1446	91
35	-6 58	1 79	6 13	3 33	1053	91
36	-6 18	85	6 60	3 22	1595	92
37	-6 95	13	6 75	3 38	- 0108	92
38	-7 12	- 34	7 21	4 10	- 0390	91
39	-7 68	-1 07	7 56	4 79	0654	92
40	-8 77	- 86	8 14	3 89	- 0422	92
41	-9 27	- 08	7 79	4 43	- 1383	92
42	-10 28	42	8 07	5 38	- 0402	92
43	-11 01	1 16	8 25	4 94	- 1165	92
44	-10 88	1 69	8 40	6 37	- 0334	90
45	-10 46	1 84	9 24	6 03	0556	91
46	-10 43	2 38	10 47	5 52	- 0067	92
47	-9 70	2 64	11 14	5 59	- 0135	90
48	-8 67	2 88	10 85	5 69	- 1214	89
49	-8 52	3 16	10 58	5 66	- 1419	89
50	-7 51	3 95	10 91	7 01	- 0479	91
51	-6 75	5 09	12 04	6 45	0397	88
52	-5 59	4 53	12 11	6 31	0116	86
53	-4 47	5 05	11 91	6 61	0246	85
54	-2 77	6 35	12 41	5 89	- 1708	84
55	28	6 65	11 03	7 36	- 3988	81
56	2 25	5 01	10 01	7 16	- 2070	77
57	2 99	3 23	10 63	6 95	- 0356	71
58	3 26	1 79	12 01	8 24	0716	66
59	3 52	2 05	13 30	8 35	0654	56
60	3 06	2 15	13 26	7 62	- 1610	48
61	2 73	2 24	12 58	8 97	- 2434	37
62	5 40	4 44	11 02	5 86	- 2111	28
63	6 92	5 16	11 13	7 65	- 1981	25
64	9 08	5 60	11 32	8 78	0692	25
65	10 76	5 56	12 21	9 27	- 2489	25
66	12 26	5 22	11 73	9 53	- 3785	23
67	13 17	5 21	10 24	8 88	- 1758	24
68	13 14	4 76	10 46	9 45	0842	21
69	14 39	4 22	10 77	10 29	2402	23
70	16 91	73	12 66	11 65	2814	22
71	17 78	-3 35	15 71	12 86	1488	23
72	19 58	-6 11	19 27	15 11	- 1648	19
73	21 06	-9 22	17 43	15 02	- 2578	18
74	17 12	-11 88	16 38	13 59	- 3444	17
75	13 15	-9 62	10 60	13 81	- 6059	13
76	6 15	-7 69	10 27	14 48	- 1594	13
77	2 68	-4 83	9 85	15 55	1217	12
78	-1 00	-2 75	10 78	16 74	3121	12
79	-3 83	- 17	12 25	17 99	3442	12
80	-5 75	2 17	14 28	18 74	3256	12
81	-6 58	4 67	16 29	19 15	2657	12
82	-6 58	7 33	17 47	18 97	1758	12
83	-7 64	13 27	16 42	15 12	4207	11
84	-4 18	16 27	16 68	12 87	1675	11
85	91	18 91	16 49	12 75	- 2400	11
86	11 00	33 75	24 83	15 42	- 9992	4

TABLE 2.10. VAFB BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

October

Alt (km)	ū	v̄	S(u)	S(v)	R(uv)	N
0	1 33	-1 25	2 93	2 64	- 3614	620
1	07	-1 94	2 98	5 27	- 0923	620
2	54	-1 64	4 49	6 21	- 2667	620
3	2 14	-2 02	6 17	7 35	- 2152	620
4	3 91	-2 51	7 78	8 72	- 0889	620
5	5 60	-2 67	8 92	9 83	0530	620
6	7 01	-2 71	10 14	11 23	1045	620
7	8 49	-2 87	11 69	12 74	1505	620
8	9 88	-2 74	13 01	14 36	2050	620
9	11 35	-2 69	14 29	15 95	2673	620
10	13 09	-2 82	15 92	16 26	3007	620
11	14 94	-2 68	15 18	16 24	3209	620
12	16 63	-2 95	14 67	15 43	3216	620
13	16 81	-2 27	12 86	13 41	2936	620
14	16 02	-1 82	11 22	11 68	2697	620
15	14 78	-1 [illegible]	9 19	9 68	2588	620
16	11 99	[illegible]	7 65	7 80	1974	620
17	8 97	1 30	6 21	5 99	1603	620
18	5 97	-1 25	5 02	4 53	1535	620
19	3 59	-1 33	4 44	3 54	2103	620
20	2 21	-1 22	4 27	3 42	2332	620
21	1 59	-1 21	4 31	3 14	2035	620
22	1 43	- 96	4 33	2 91	2176	620
23	1 43	- 77	4 55	2 89	1465	620
24	1 92	- 66	4 98	2 94	1258	620
25	2 34	- 45	5 48	2 89	0966	620
26	3 28	- 21	6 23	3 00	1811	620
27	4 28	- 15	6 91	3 30	2076	620
28	4 90	- 29	8 34	3 18	2193	101
29	6 47	04	8 78	3 30	2631	100
30	8 39	37	9 67	3 60	4205	108
31	10 40	99	10 42	3 82	4604	111
32	12 09	1 82	10 67	4 15	2867	113
33	13 96	2 42	10 58	4 58	2895	113
34	15 16	3 18	11 28	5 09	3134	116
35	17 62	3 62	11 13	5 89	2075	115
36	19 48	2 94	11 77	5 40	4170	115
37	21 78	2 67	11 53	5 57	5098	115
38	23 25	2 26	13 30	5 88	4757	115
39	24 57	1 59	14 92	6 10	3415	115
40	26 52	1 15	15 03	5 66	3147	115
41	27 37	1 00	15 66	5 65	1700	117
42	28 84	1 12	16 92	5 86	0311	117
43	30 29	1 02	17 00	6 02	0337	117
44	31 28	1 79	16 42	6 12	0358	117
45	32 82	2 10	16 69	7 03	- 0203	116
46	35 19	4 10	15 95	7 55	- 0037	115
47	37 42	4 96	16 14	7 75	1256	113
48	39 35	6 10	16 88	8 17	2181	115
49	41 04	6 99	17 61	8 17	2723	115
50	41 96	7 63	18 13	8 30	2142	115
51	43 89	8 26	17 76	8 09	1288	112
52	45 11	8 43	17 65	8 69	1989	111
53	46 47	8 55	17 89	8 85	3120	109
54	47 41	9 08	17 60	8 93	3906	108
55	48 53	9 55	17 44	8 74	4572	108
56	49 92	9 51	17 01	8 56	4832	107
57	50 20	9 64	16 84	9 05	4835	104
58	49 88	8 73	18 23	9 82	5344	98
59	49 68	7 98	19 39	11 05	5716	82
60	52 40	7 97	18 39	11 57	4355	67
61	52 58	7 34	19 22	9 97	4906	53
62	52 95	5 14	20 79	11 84	6645	44
63	50 73	5 42	21 14	11 27	6057	33
64	52 24	5 79	22 97	12 20	7066	33
65	51 09	4 22	24 09	12 58	6201	32
66	49 50	3 34	25 65	12 31	4629	32
67	46 81	2 09	28 74	12 11	311.	32
68	44 83	2 07	31 49	12 91	1044	30
69	39 48	1 77	32 11	14 27	- 0579	30
70	40 69	1 45	28 43	14 36	- 1200	29
71	39 67	- 27	23 99	15 13	- 3723	30
72	36 23	- 83	17 00	16 93	- 4619	30
73	33 37	-2 85	15 36	18 76	- 4678	27
74	29 [illegible]	-5 05	15 68	19 18	- 7382	22
75	22 25	-4 40	15 85	20 38	- 7489	20
76	14 40	-2 30	13 32	19 83	- 6205	20
77	9 20	15	12 32	19 35	- 5045	20
78	4 58	3 50	11 36	19 24	- 2345	20
79	65	6 55	11 27	19 92	0854	20
80	-1 90	9 25	12 10	17 90	3140	20
81	-3 95	11 42	13 52	17 05	4498	19
82	-3 26	14 21	15 06	16 81	4791	19
83	1 26	16 63	16 33	15 05	4605	19
84	2 47	18 21	16 77	14 64	3007	14
85	7 61	20 22	16 87	14 16	3247	16
86	12 17	22 17	12 87	11 22	- 3515	12
87	26 40	11 40	15 58	9 77	- 1364	5
88	27 00	6 00	13 93	14 17	- 4511	3

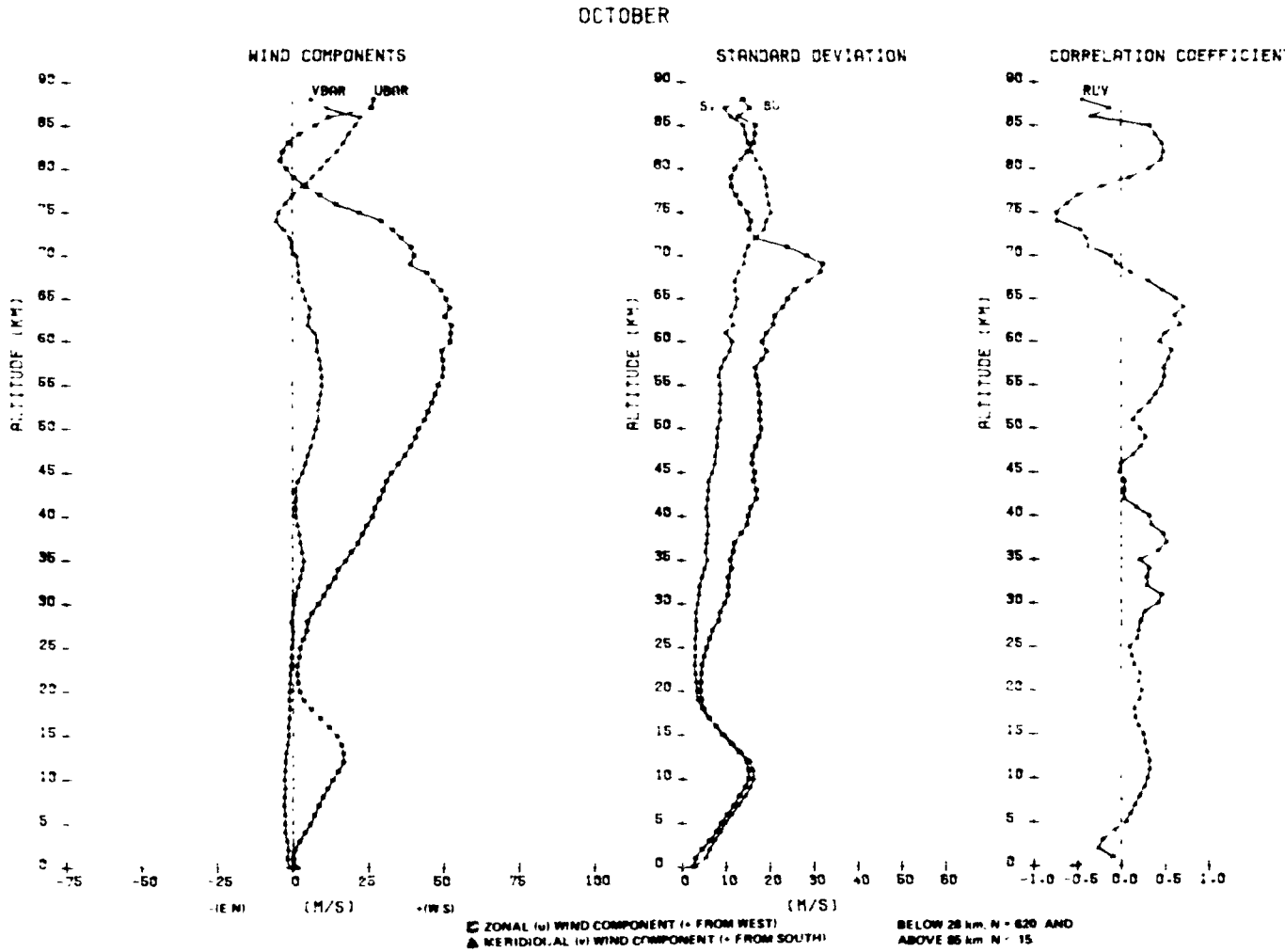

Figure 2.10. VAFB bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 2.11. VAFB BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

November

Alt (km)	ū	v̄	S(u)	S(v)	R(uv)	N
0	70	- 9[illegible]	2 69	3 11	- 9711	600
1	42	-1 19	3 93	6 89	- 1256	600
2	2 22	-1 04	5 19	7 98	0002	600
3	4 88	-1 44	6 09	9 22	0324	600
4	7 45	-1 43	8 51	10 27	0557	600
5	9 69	-1 24	10 28	11 68	1543	600
6	11 85	-1 53	11 68	13 66	2371	600
7	13 78	-1 65	13 06	15 67	2947	600
8	15 57	-1 76	14 45	17 6[illegible]	3273	600
9	17 27	-1 64	15 71	19 22	3727	600
10	19 06	-1 77	16 91	20 59	4074	600
11	20 59	-1 34	17 46	20 66	4371	600
12	21 74	- 90	16 96	19 12	4380	600
13	21 38	- 41	15 16	16 42	4344	600
14	19 89	11	12 61	13 86	4379	600
15	17 61	- 08	10 42	11 12	4373	600
16	14 62	- 30	8 65	9 13	3863	600
17	12 24	- 53	7 42	7 26	3477	600
18	9 12	- 79	6 47	5 63	3127	600
19	6 91	-1 05	6 45	4 75	2838	600
20	5 19	-1 29	6 06	4 14	2919	600
21	4 37	-1 56	6 18	3 66	2403	600
22	4 13	-1 79	6 64	3 60	2496	600
23	4 18	-1 70	7 17	3 45	2298	600
24	4 79	-1 32	7 94	3 29	2319	600
25	5 71	- 98	8 91	3 51	2116	600
26	6 99	- 85	10 02	3 54	2818	600
27	8 57	- 75	11 45	4 66	4206	600
28	12 98	46	9 76	3 89	5593	5[illegible]
29	14 82	97	10 90	4 61	6374	66
30	16 22	1 19	12 95	5 94	6369	67
31	18 55	1 48	14 29	5 15	7102	71
32	20 61	2 12	15 21	6 42	6734	72
33	21 93	2 52	16 28	7 08	6398	71
34	25 47	3 07	17 18	7 44	6080	72
35	27 97	3 34	16 73	8 15	5943	74
36	30 22	3 65	15 7[illegible]	7 20	6081	72
37	34 19	3 61	17 00	7 63	7755	72
38	36 06	3 01	1 15	7 21	7364	72
39	38 57	1 96	18 29	7 94	7398	70
40	40 93	1 28	18 41	8 41	7525	72
41	41 66	1 16	18 45	8 20	7469	70
42	43 63	1 52	17 83	7 30	5942	71
43	45 92	1 80	17 78	8 46	4311	71
44	48 93	2 37	17 70	8 51	3831	70
45	52 16	3 16	17 78	8 55	3170	70
46	55 06	3 43	17 94	9 18	2969	70
47	57 83	4 17	18 37	10 30	2909	71
48	60 59	4 14	19 12	11 63	2994	71
49	63 49	7 17	19 82	13 40	3658	70
50	67 35	8 65	21 30	13 63	3865	69
51	68 12	9 13	22 28	13 78	3692	69
52	69 43	8 76	21 76	15 10	3545	68
53	70 96	8 75	21 39	15 42	3573	68
54	71 85	8 56	21 76	15 33	3195	66
55	72 57	7 86	21 46	14 56	2302	65
56	72 67	7 76	22 67	14 47	1644	64
57	72 95	6 21	21 38	15 30	1812	63
58	71 47	4 38	21 23	16 66	2306	60
59	68 16	1 62	22 11	18 81	3241	56
60	64 81	1 45	23 67	17 36	3305	42
61	64 10	-1 55	24 14	16 23	5422	31
62	65 48	-2 61	27 37	15 45	6032	23
63	67 70	-5 40	29 08	15 02	6373	20
64	64 50	-3 81	36 16	12 49	6749	16
65	67 71	-1 14	29 3[illegible]	16 87	9490	14
66	65 47	-3 87	27 86	14 91	4234	15
67	70 32	-1 33	28 33	14 13	2984	12
68	64 13	-6 13	28 46	13 78	4906	15
69	62 27	-6 40	28 97	14 24	3797	15
70	[illegible]9 21	-5 79	30 24	16 55	3900	14
71	53 47	-7 33	29 45	20 00	4706	15
72	46 64	-6 86	29 13	22 90	5685	1[illegible]
73	42 50	-5 33	26 24	20 47	4883	12
74	47 25	4 75	24 27	16 11	3307	8
75	43 00	5 37	22 81	14 03	2746	8
76	38 87	5 63	21 7[illegible]	13 37	0321	8
77	34 50	5 06	21 19	14 49	- 2249	8
78	30 37	4 12	21 38	17 72	- 4871	5
79	26 75	2 87	21 86	21 59	- 4468	8
80	23 50	1 37	23 11	25 54	- 3794	8
81	21 00	- 50	24 63	28 94	- 2671	8
82	18 87	-2 37	26 41	31 14	- 0919	8
83	17 50	-4 00	27 91	31 95	0576	8
84	16 37	-5 37	29 69	30 53	2242	8
85	16 12	-6 62	30 29	28 09	3364	9
86	16 25	-7 00	15 11	24 49	5135	4
87	29 00	-5 75	16 20	15 10	7713	4
88	22 33	-1 3[illegible]	20 43	11 15	9811	3

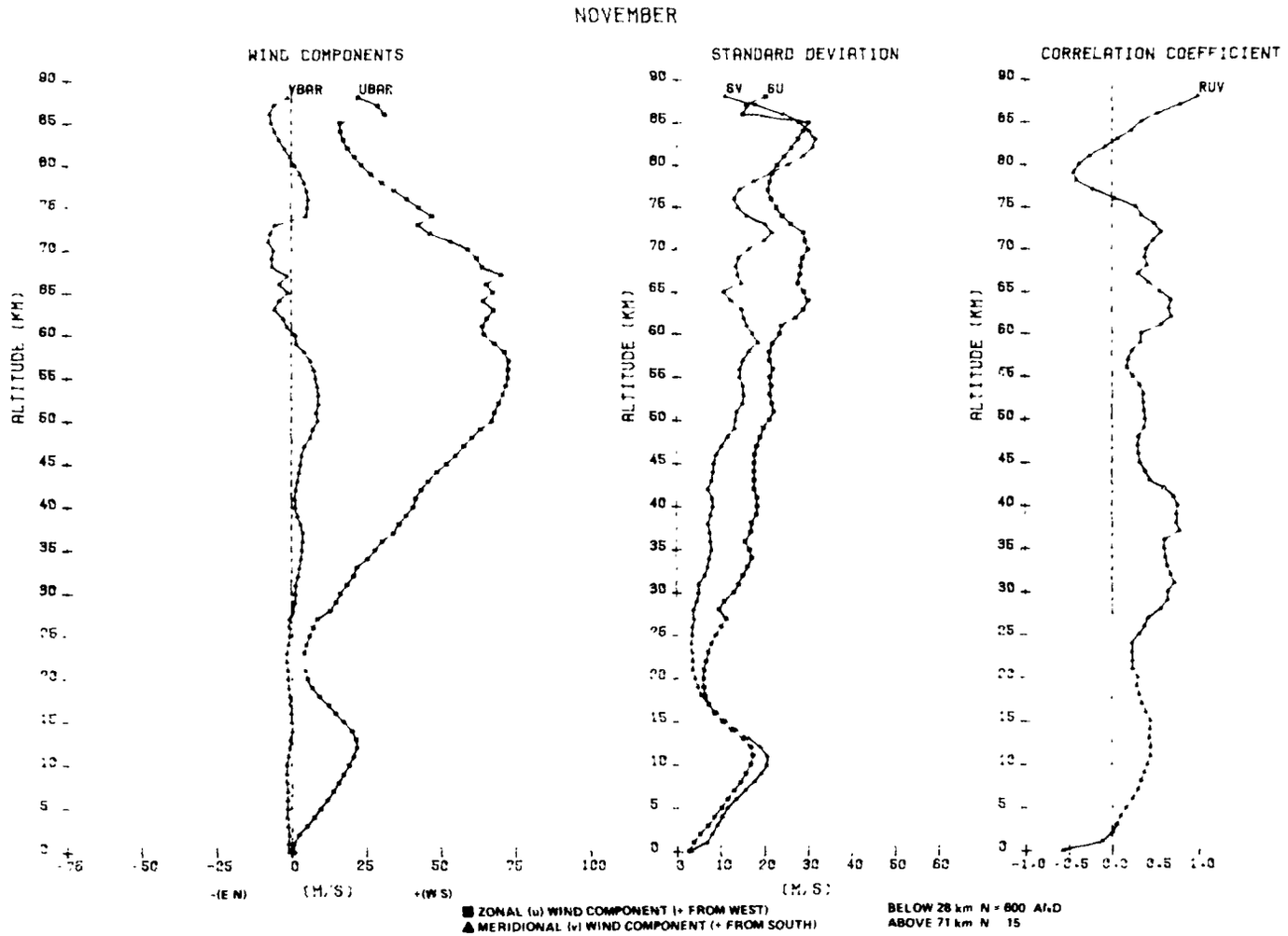

Figure 2.11. VAFB bivariate normal wind statistics, 90 degree flight azimuth.

TABLE 2.12. VAFB BIVARIATE NORMAL WIND STATISTICS, 90 DEGREE FLIGHT AZIMUTH

December

Alt (km)	ū	v̄	S(u)	S(v)	R(uv)	N
0	42	-1 10	2 83	3 19	-.4912	620
1	1 26	-2 66	4 47	7 29	-.0611	620
2	3 06	-3 63	5 80	8 50	.0404	620
3	4 77	-4 34	7 94	9 85	.0973	620
4	9 62	-4 95	9 38	11 60	.1032	620
5	12 03	-5 36	10 96	13 02	.1663	620
6	14 15	-5 89	12 39	14 87	.2362	620
7	16 21	-6 43	14 05	16 83	.3037	620
8	18 23	-6 67	15 60	18 32	.3939	620
9	20 20	-7 09	16 77	19 84	.3781	620
10	22 04	-7 14	17 47	20 94	.4048	620
11	23 47	-6 98	17 02	20 60	.3873	620
12	24 04	-6 00	15 52	18 85	.3938	620
13	23 41	-4 83	13 90	16 23	.3869	620
14	21 68	-3 76	11 78	13 94	.3941	620
15	19 36	-3 13	10 00	11 72	.4016	620
16	16 25	-2 72	8 84	9 77	.4085	620
17	13 07	-2 31	7 83	8 26	.4364	620
18	9 49	-2 23	6 71	6 35	.4716	620
19	6 20	-2 34	6 07	4 95	.4525	620
20	3 93	-2 50	5 97	4 26	.3638	620
21	1 91	-2 66	5 99	3 95	.2496	620
22	37	-2 53	6 41	3 80	.2832	620
23	40	-2 48	7 23	3 59	.2116	620
24	-.57	-2 73	7 77	3 59	.1918	620
25	-.84	-2 52	8 63	3 53	.2330	620
26	56	-2 49	9 99	3 96	.2718	620
27	38	-2 67	11 78	4 53	.3282	620
28	17	-3 03	13 65	4 94	.3967	106
29	-.13	-3 18	15 22	4 78	.5140	108
30	4 52	-3 20	17 65	5 48	.5903	113
31	6 86	-3 19	18 71	6 40	.6226	111
32	9 51	-2 79	20 17	7 01	.6830	110
33	14 00	-2 26	22 75	7 86	.7448	112
34	18 29	-1 53	24 38	8 75	.7516	113
35	22 04	.09	25 28	9 45	.7375	112
36	26 55	.22	26 22	10 17	.7641	113
37	31 68	.12	27 04	10 67	.7702	112
38	36 19	.03	27 37	11 06	.7567	114
39	39 77	.04	27 19	11 28	.7617	111
40	42 83	.17	27 23	11 77	.7349	114
41	45 87	1 35	27 99	13 06	.6655	110
42	48 88	3 02	28 51	14 11	.5957	110
43	53 18	4 46	29 94	14 46	.5164	111
44	57 08	6 14	28 86	14 90	.4416	112
45	60 79	7 65	28 65	15 63	.3723	110
46	63 97	9 41	28 87	16 39	.3035	111
47	67 35	11 59	28 74	16 41	.3116	113
48	70 04	13 00	28 86	16 97	.2797	112
49	72 05	14 28	28 58	17 59	.2734	109
50	73 92	14 67	29 24	18 40	.2191	106
51	75 08	14 23	29 09	17 95	.1898	108
52	76 38	15 02	29 36	18 91	.1559	108
53	77 19	14 67	29 87	17 75	.1501	106
54	77 14	14 57	29 66	17 38	.1622	106
55	78 67	13 91	29 99	16 80	.0698	103
56	78 75	11 93	30 38	18 05	.0278	99
57	78 57	10 00	29 99	19 65	.0012	93
58	78 51	12 06	30 49	21 88	.1326	89
59	79 89	12 51	31 18	23 15	.1744	75
60	76 98	10 59	34 74	23 43	.2544	94
61	75 62	5 53	34 24	24 43	.1737	32
62	66 76	3 38	33 96	22 77	.0731	21
63	69 73	6 53	33 16	18 59	.2412	15
64	69 94	7 00	29 87	15 68	.4678	16
65	66 13	8 40	28 03	17 35	.7231	15
66	64 20	7 73	28 53	18 78	.9116	15
67	63 17	9 75	31 69	15 96	.7011	12
68	60 85	4 92	32 18	18 40	.3654	13
69	61 93	.00	32 28	17 72	.3567	14
70	60 92	2 00	34 46	13 97	.6552	12
71	57 08	1 38	32 15	20 62	.5138	13
72	53 92	.46	30 98	22 33	.4664	13
73	56 09	4 91	28 16	23 85	.2784	11
74	54 73	7 09	24 92	24 54	.2137	11
75	54 20	9 80	22 30	26 60	.2352	10
76	51 80	10 10	18 37	25 87	.3741	10
77	49 60	9 20	15 42	25 25	.5487	10
78	47 90	7 50	14 23	24 24	.6515	10
79	44 10	5 90	15 29	22 78	.5755	10
80	41 30	2 70	18 23	21 28	.3401	10
81	38 30	-.26	21 45	20 40	.0523	10
82	34 90	-3 50	24 28	20 59	-.2082	10
83	33 56	-4 00	27 43	22 22	-.5057	9
84	29 89	-7 78	28 92	26 07	-.5441	9
85	26 67	-11 44	28 56	29 41	-.5107	9
86	15 33	-26 67	33 48	36 75	-.5011	3

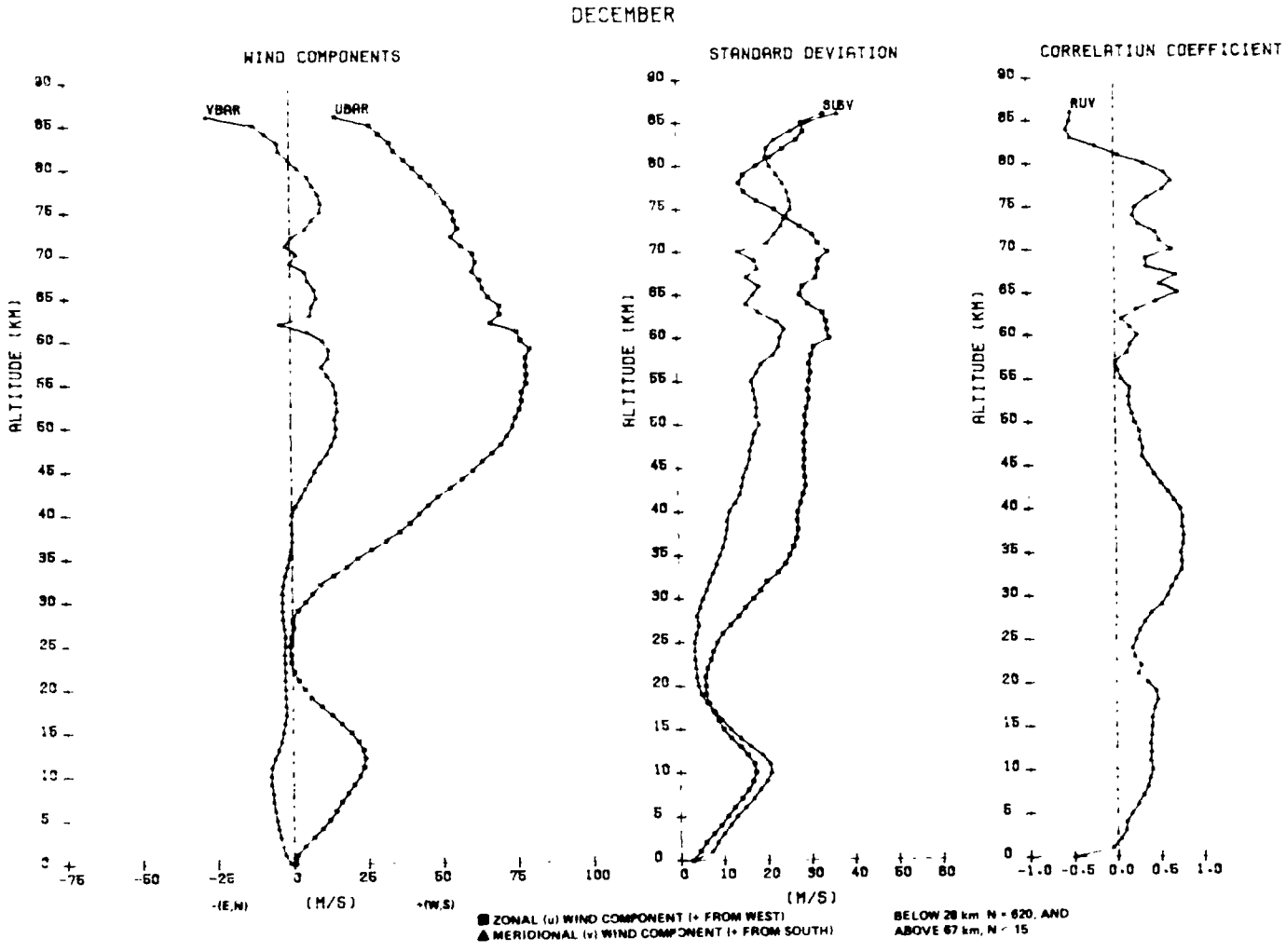

Figure 2.12. VAFB bivariate normal wind statistics, 90 degree flight azimuth.

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APPROVAL

SURFACE TO 90 km WINDS FOR KENNEDY SPACE CENTER, FLORIDA, AND VANDENBERG AFB, CALIFORNIA

By D. L. Johnson and S. C. Brown

The information in this report has been reviewed for technical content. Review of any information concerning Department of Defense or nuclear energy activities or programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

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